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DIPOLE & ABSOLUTE MAGNITUDE ANALYSIS OF THE SCP UNION SUPERNOVAE WITHIN THE EXPANSION CENTER MODEL

ECM paper XVI by Luciano Lorenzi

by merging the SAI 2011 ECM paper XI with the EWASS 2012 ECM paper XIII

ABSTRACT

1743 data calculated for 249 High- z SCP Union supernovae are analysed according to the expansion center model (ECM). The analysis in Hubble units begins with 13 listed normal points corresponding to 13 z -bin samples at as many Hubble depths. The novel finding is a clear drop in the average scattering of the SNe Ia Hubble Magnitude M with the Hubble depth D , after using the average trend $\langle M \rangle$ computed in paper IX. Other correlations of the M scattering with the position in the sky are proposed. Consequently, 13 ECM dipole tests on the 13 z -bin samples were carried out both with unweighted and weighted fittings. A further check was made with Hubble depths D obtained by assuming $M \equiv \langle M \rangle$ according to paper IX and XV. In conclusion the analysis of 249 *SCPU* SNe confirms once again the ECM at any Hubble depth, including a strengthening ΔM perturbation effect at decreasing $z \lesssim 0.5$. A new successful dipole test introduces the absolute magnitude analysis of 398 *SCPU* supernovae. After testing 14 high- z normal points $\langle M_B \rangle$ from paper IX Table 2, a trend analysis of another 15 and 30 normal points of the Hubble Magnitude M and a new absolute magnitude M^* , at increasing $\langle z \rangle \equiv z_0$ corresponding to a different series of z bins, leads to the discovery of the magnitude anomaly of the low $\langle z \rangle$ points. When the low $\langle z \rangle$ points are excluded, the best fittings make it possible to extrapolate the SNe Ia absolute magnitude M_0 at a central redshift $z_0 \rightarrow 0$, with $M_0 = -17.9 \pm 0.1$ and a few final ECM solutions of the SNe Ia $\langle M \rangle$ and $\langle M^* \rangle$. The magnitude anomaly is here interpreted as due to a deficiency in the magnitude formulas used; these produce a maximum peak of deviation, with a systematic $\Delta M \approx 1$ in the range $0.04 \lesssim \langle z \rangle \lesssim 0.08$. That is a proof of the Universe rotation within the expansion center model.

1. Introduction

The present work, which results to be a fusion of paper XI with paper XIII presented at EWASS 2012, is to all intents a further and necessary supplement to complete the parallel paper XV, which represents the final crucial proof of the expansion center Universe. In that paper, the model independent dipole test was limited to z bins centred on $\langle z \rangle = 1$. Here the aim is the ECM dipole analysis of 13 z bins at different Hubble depths, using 249 supernovae lying within the range $0.2 < z < 1.4$ from the selected 307 SNe Ia of the SCP Union compilation (*SCPU*: Kowalski et. al. 2008), in order to show how the wedge-shaped Hubble diagram of paper IX is affected by both the ECM dipole anisotropy and a ΔM effect that appears to be more perturbative at decreasing $z \lesssim 0.5$. Indeed, having confirmed the expansion center model (ECM), here the ECM is used to check and explore more thoroughly the SNe Ia behaviour at varying Hubble depths and positions in the sky. Hence the analysis of the SNe Ia absolute magnitude bases itself on the data of the whole SCP Union sample, which reports redshifts and blue apparent magnitudes of 398 SNe Ia. Owing to the cited strengthening perturbation effect of the scattering of the Hubble Magnitude M at decreasing $z < 0.5$, new $\langle M \rangle$ fittings limited to normal points with $\langle z \rangle > 0.55$ from paper IX Table 2 have been explored. After the successful check, 30 new normal points from the data of all the 398 *SCPU* SNe have been constructed, in order to better analyse the SN magnitude trend at different Hubble depths. The main construction and analysis of the magnitude normal points does not involve the expansion center model. In other words the main experimental results obtained, the SNe absolute magnitude value M_0 and the trend of the Hubble Magnitude M , can be considered both model independent and able to confirm once again the ECM. In particular the new findings provide astronomical evidence for cosmic rotation around the expansion center, in accordance with the limits of the ECM itself, which formally, as one must recall, implies a rigid rotation of the very nearby Universe (cf. paper VII).

All the plots and graphical fittings of this analysis appear in the Appendix "Atlas of the ECM paper XVI figures". Moreover, as we deal only with blue magnitudes, the pedicel B becomes superfluous; thus the convention $M_B \equiv M$ is adopted within this paper XVI as in paper XV.

The cited papers I-II-III-IV-V-VI-VII-VIII-IX-X-XI-XII-XIII-XV are those referenced as Lorenzi 1999a→2012d, while S&T is for Sandage & Tammann 1975a, B&S for Bahcall & Soneira 1982, P99 for Perlmutter et al. 1999, K03 for Knop et al. 2003.

2. ECM values from the observed (z, m, γ)

2.1 ECM standard values

The ECM Hubble law in Hubble units (cf. papers V-VI-IX),

$$cz = [H_0 - a_0 X] \cdot D = H_X \cdot D \quad \text{with} \quad H_X = H_0 - a_0 X \quad (1)$$

where

$$X = \cos \gamma \cdot (1 - x)^{\frac{1}{3}} / (1 + x) \quad D = \frac{xc}{3H_0} \left(\frac{1 + x}{1 - x} \right) \quad r = \frac{xc}{3H_0} \quad (2)$$

and after introducing the ECM standard values (based on data by S&T)

$$\mathbf{H}_0 \equiv \mathbf{70} \text{ km s}^{-1} \text{ Mpc}^{-1} \quad \mathbf{a}_0 \equiv \mathbf{12.7} \text{ km s}^{-1} \text{ Mpc}^{-1} \quad (3)$$

allows us to give each supernova at (α, δ) the ECM light space r_z , Hubble depth D_z and Hubble Magnitude $M_z = M(D_z)$, being $D_L \equiv D_C$ assumed (cf. papers V-VI-IX-XV) and $z, m = m_B^{\max}$ available from literature together with the computed value of $\cos \gamma = \sin \delta_{VC} \sin \delta + \cos \delta_{VC} \cos \delta \cos(\alpha - \alpha_{VC})$ with $\alpha_{VC} \approx 9^h$ and $\delta_{VC} \approx +30^0$ (B&S), as follows:

$$[z, \cos \gamma] \Rightarrow x = x(z, \cos \gamma) \Rightarrow r = r_z; \quad D = D_z; \quad X = X_z \Rightarrow cz \equiv H_X \cdot D_z \Rightarrow \quad (4)$$

$$[m = m_B^{\max}] \Rightarrow D_C = D_z \cdot (1 + z) = \frac{xc}{3H_0} \left(\frac{1 + x}{1 - x} \right) (1 + z) \Rightarrow M_z = m - 5 \log D_C - 25 \quad (5)$$

2.2 Computation of the M scattering

The ECM Hubble Magnitude M_z needs to be compared with the model independent value $\langle M \rangle$, which comes from the $M(D)$ average trend computed in paper IX, whose eq. (22) gives the fitting curve of 30 normal points from 398 SNe listed in Table 11 of the *SCPU* compilation (Kowalski et al. 2008). Here the computation of $\langle M \rangle$, then the scattering $\Delta M = M_z - \langle M \rangle$, utilizes the ECM Hubble depth D_z with the same parameters $d_0 d_1 d_2$, according to the following expressions:

$$\cos \gamma = 0 \Rightarrow z = z_0 \Rightarrow D = \frac{cz_0}{H_0} \quad \text{and} \quad \cos \gamma \neq 0 \Rightarrow D = \frac{cz}{H_X} = D_z \Rightarrow \quad (6)$$

$$M(z_0) = A_0 + A_1 z_0 + A_2 z_0^2 = d_0 + d_1 D_z + d_2 D_z^2 = \langle M \rangle \quad (7)$$

$$d_0 = A_0 \cong -18.77; \quad d_1 \cong -1.421 \cdot H_0/c; \quad d_2 \cong +0.3589 \cdot H_0^2/c^2 \quad (8)$$

$$\Delta M = M_z - \langle M \rangle \quad (9)$$

2.3 Computation of the Hubble depth $D_{\langle M \rangle}$

On the basis of the previous formulations, one can finally calculate the Hubble depth $D_{\langle M \rangle}$ corresponding to the Hubble Magnitude equal to its average value $\langle M \rangle$ of eq. (7). To this end consider some sequential steps:

$$\langle M \rangle = M_z - \Delta M = m - 5 \log D_C - 25 - \Delta M \quad (10)$$

$$\log [D_z(1+z)] = 0.2(m - \langle M \rangle - \Delta M) - 5 \quad (11)$$

$$D_z = 10^{0.2(m - \langle M \rangle - \Delta M) - 5} / (1+z) \quad (12)$$

$$D_{\langle M \rangle} = 10^{0.2(m - \langle M \rangle) - 5} / (1+z) \quad (13)$$

$$D_{\langle M \rangle} = D_z \cdot 10^{0.2\Delta M} \quad (14)$$

$$\Delta M \rightarrow 0 \Rightarrow M_z \rightarrow \langle M \rangle \Rightarrow D_{\langle M \rangle} \rightarrow D_z \quad (15)$$

2.4 Weighted ECM Hubble law

It is clear that only the Hubble depth $D_{\langle M \rangle}$ can be obtained, if we exclude the ECM value of D_z . So the check of a_0 in eq. (1), after introducing $D = D_{\langle M \rangle}$ from eq. (13), should take into account the ΔM perturbation. That may be done through an ECM Hubble law weighted by w_i with $i = 0, 1, 2$, as follows:

$$cz = (H_0 - a_0 X_z) \cdot D_{\langle M \rangle} \Rightarrow Y = \frac{cz}{D_{\langle M \rangle}} - H_0 \rightarrow -X_z \Rightarrow a_0 \quad \text{with} \quad w_i \propto |\Delta M|^{-i} \quad (16)$$

3. ECM dipole analysis of 249 High- z SCP Union SNe Ia

The ECM values for each of the 249 SNe Ia (those of Table 3 in Appendix of paper IX and cited in the papers X-XV as pilot sample XVI) are listed in the corresponding Table 3 of section 4.

3.1 Construction of 13 normal points

Table 0 below lists a set of normal points referring to the pilot sample XVI and to 12 derived samples. In particular the 10 columns of Table 0 present the following data for each SNe sample, in order: Sample ordinal number; number N of the sample SNe; sample z bin; mean $\langle z \rangle$ of the z bin; unweighted mathematical mean $\langle m_B^{\max} \rangle$ of the corresponding SNe magnitudes; mean $\langle \cos \gamma \rangle$ of the SNe $\cos \gamma$; relative scattering of the average Hubble depth of the sample SNe, as $\frac{\Delta D}{D}$ where

$\Delta D = \langle D_z \rangle - D$ and $D = \frac{c\langle z \rangle}{H_0}$ with $\langle z \rangle \equiv z_0$ assumed; average Hubble depth of the sample SNe, as $\langle D_z \rangle$, whose individual D_z come from the ECM solution (4); average Hubble Magnitude $\langle M_z \rangle$ of the sample SNe whose individual M_z follow from eq. (5); average scattering in modulus of the sample SNe Hubble Magnitudes, as $\langle |\Delta M| \rangle$ whose individual $|\Delta M| = |M_z - \langle M \rangle|$ follow from the M_z eq. (5) and the average trend $\langle M \rangle = d_0 + d_1 D_z + d_2 D_z^2$ according to eqs. (7)(8).

Table 0

Sample	N	z bin	$\langle z \rangle$	$\langle m \rangle$	$\langle \cos \gamma \rangle$	$\frac{\Delta D}{D}$	$\langle D_z \rangle$	$\langle M_z \rangle$	$\langle \Delta M \rangle$
XVI ₁₁	50	$0.2 < z \leq 0.4$	0.322	22.123	-0.00	0.03	1425	-19.146	0.342
XVI ₁₂	101	$0.2 < z \leq 0.5$	0.387	22.534	+0.06	0.04	1716	-19.235	0.330
XVI ₁₃	142	$0.2 < z \leq 0.6$	0.434	22.762	+0.03	0.02	1893	-19.304	0.302
XVI ₁₄	174	$0.2 < z \leq 0.7$	0.472	22.928	+0.00	0.01	2037	-19.357	0.289
XVI ₁₅	192	$0.2 < z \leq 0.8$	0.499	23.040	+0.03	0.01	2152	-19.389	0.279
XVI ₁₆	215	$0.2 < z \leq 0.9$	0.535	23.195	+0.05	0.02	2332	-19.417	0.271
XVI	249	$0.2 < z < 1.4$	0.607	23.440	+0.08	0.02	2651	-19.482	0.259
XVI ₁₇	200	$0.4 \leq z < 1.4$	0.677	23.763	+0.10	0.02	2951	-19.567	0.239
XVI ₁₈	149	$0.5 \leq z < 1.4$	0.756	24.052	+0.10	0.01	3282	-19.650	0.210
XVI ₁₉	107	$0.6 \leq z < 1.4$	0.837	24.339	+0.15	0.02	3658	-19.719	0.202
XVI ₂₀	75	$0.7 \leq z < 1.4$	0.919	24.627	+0.28	0.03	4075	-19.773	0.188
XVI ₂₁	58	$0.8 \leq z < 1.4$	0.969	24.784	+0.26	0.04	4323	-19.789	0.193
XVI₁	48	$0.83 \leq z < 1.4$	1.001	24.836	+0.29	0.03	4409	-19.852	0.175

By an unweighted fitting of the 13 normal points of Table 0, plotting the listed $\langle |\Delta M| \rangle$ values versus the corresponding $\langle D_z \rangle$ as shown in Appendix Figure 1, one can draw an important relationship, according to the following two formulations:

$$\langle |\Delta M| \rangle = 0.40(\pm 0.01) - 0.000053(\pm 0.000004) \cdot \langle D_z \rangle \quad (17)$$

$$\langle |\Delta M| \rangle = 1.42(\pm 0.05) - 0.15(\pm 0.01) \cdot \ln(\langle D_z \rangle) \quad (18)$$

which are well confirmed by the corresponding two unweighted fittings of the 249 $|\Delta M|$ from Table 3abcdefghi, as follows:

$$\langle |\Delta M| \rangle = 0.40(\pm 0.04) - 0.000052(\pm 0.000013) \cdot D_z \quad (19)$$

$$\langle |\Delta M| \rangle = 1.45(\pm 0.26) - 0.15(\pm 0.04) \cdot \ln(D_z) \quad (20)$$

Both the previous correlations, (19) and (20), are shown in Appendix Figure 2, as fitting lines which run very near to each other at all the 249 SNe Hubble depths. At the same time, plotting the $\langle M_z \rangle$ values versus the corresponding $\langle D_z \rangle$ for the 13 normal points of Table 0, as shown in Appendix Figure 3, allows a quick check of the fitting curve II (2^{nd} order), whose ECM equation

$$\langle M_z \rangle \cong -18.62\text{E}00 - 4\text{E-}04\langle D_z \rangle + 3\text{E-}08\langle D_z \rangle^2 \quad (21)$$

results to agree with the paper IX eq. (22), that based on 30 (practically model independent) normal points, including all the 398 SNe Ia with z and m_B^{\max} listed in Table 11 of the *SCPU* compilation (Kowalski et al. 2008). Let us recall the paper IX values $d_0 = -18.77\text{E}00$, $d_1 = -3.318\text{E-}04$, $d_2 = 1.957\text{E-}08$, also used in paper XV and in the present dipole analysis, according to eqs. (7)(8)(9). Other two fitting curves, III and IV (of 3^{rd} and 4^{th} order respectively), are represented in Appendix Figures 4 and 5, where the relative equations show the peculiarity of a systematic reduction in modulus of the zero order coefficient, according to the corresponding values: -18.77 , -18.62 , -18.51 , -18.36 .

Appendix Figure 6 shows the plot and cubic fitting of the 249 SNe M_z listed in Table 3abcdefghi against the corresponding D_z . It is important to remark that here the zero order coefficient, as -18.15 , has a value in modulus smaller than the previous ones.

From the 249 ΔM values of Table 3abcdefghi, even a few rough correlations of $|\Delta M|$ with $\cos \gamma$ seem to come out; these are:

$$\langle |\Delta M| \rangle \approx 0.26 - 0.05 \cdot \cos \gamma \quad \text{at} \quad 0.2 < z < 1.4 \quad (22)$$

$$\langle |\Delta M| \rangle \approx 0.34 - 0.10 \cdot \cos \gamma \quad \text{at} \quad 0.2 < z \leq 0.5 \quad (\text{see Appendix Figure 7}) \quad (23)$$

$$\langle |\Delta M| \rangle \approx 0.21 - 0.00 \cdot \cos \gamma \quad \text{at} \quad 0.5 < z < 1.4 \quad (24)$$

A further remark about the data of Table 0 regards the 7^{th} column, where the small positive values of $\frac{\Delta D}{D}$ may indicate a systematic scattering of $\langle z \rangle$ from z_0 . Furthermore ΔD has here the same behaviour as in Table 1b of the parallel paper XV. For instance the sample XVI₁ of Table 0, whose $\langle D_z \rangle = cz_0/H_0$, gives $z_0 = 1.029$ and $\langle z \rangle - z_0 = -0.028$ or $|\frac{\Delta z}{z}| \cong 0.03$. At the same time the dipole tests A1 and B1 of paper XV, with $\langle D \rangle = cz_0/H_0$, give $z_0 = 1.032$ and $z_0 = 1.045$, that is the corresponding $\langle z \rangle - z_0 = -0.031$ and $\langle z \rangle - z_0 = -0.044$, or $|\frac{\Delta z}{z}| \cong 0.03$ and 0.04 , respectively.

3.2 ECM dipole tests weighted by $w_i \propto |\Delta M|^{-i}$

The results of the dipole test based on the weighted ECM Hubble law (16), applied to each supernova of Table 3abcdefghi with weight $w_i \propto |\Delta M|^{-i}$, are listed in Table 1. Here the 9 columns present three ECM dipole solutions for each SNe sample, with $i = 0, 1, 2$ respectively, as follows: Test identification name (TID); sample ordinal number; number N of the sample SNe; the fitting standard deviation $s(w_0)$ in H.u. of the unweighted ECM dipole test carried out on the line sample and the resulting angular coefficient a_0 of eq. (16) with its standard deviation, in H.u., corresponding to the weight applied $w_0 = 1$ to each sample SNe; the standard deviation $s(w_1)$ in H.u. of the fitting with $w_1 = |\Delta M|^{-1}$ together with the resulting a_0 in H.u.; the standard deviation $s(w_2)$ in H.u. of the fitting with $w_2 = |\Delta M|^{-2}$ together with the resulting a_0 in H.u..

Table 1

TID	Sample	N	$s(w_0)$	a_0	$s(w_1)$	a_0	$s(w_2)$	a_0
W11	XVI ₁₁	50	12.52	-1.2 ± 5.1	4.40	11.3	0.45	12.7
W12	XVI ₁₂	101	11.62	-2.9 ± 3.7	4.63	11.0	0.57	12.8
W13	XVI ₁₃	142	10.95	-1.4 ± 3.0	4.09	11.0	0.57	12.7
W14	XVI ₁₄	174	10.92	1.8 ± 2.8	4.20	11.3	0.62	12.7
W15	XVI ₁₅	192	10.62	2.3 ± 2.6	4.18	11.3	0.65	12.7
W16	XVI ₁₆	215	10.42	3.1 ± 2.4	3.73	11.3	0.45	12.7
W0	XVI	249	10.11	4.3 ± 2.2	3.75	11.6	0.48	12.75
W17	XVI ₁₇	200	9.409	6.6 ± 2.4	3.60	11.9	0.49	12.8
W18	XVI ₁₈	149	8.547	10.8 ± 2.6	3.22	12.4	0.44	12.7
W19	XVI ₁₉	107	8.254	14.1 ± 3.0	3.26	13.5	0.40	13.3
W20	XVI ₂₀	75	7.618	11.8 ± 3.3	2.82	12.9	0.33	13.3
W21	XVI ₂₁	58	7.794	12.7 ± 3.9	2.65	13.5	0.29	13.3
W1	XVI₁	48	7.109	14.4 ± 3.9	2.39	14.1	0.26	13.4

At first sight the results in Table 1 seem to suggest that only the high values of $\langle |\Delta M| \rangle$ in the 10th column of Table 0, corresponding to $z \lesssim 0.5$, are significantly affecting the unweighted ECM Hubble law (4th and 5th columns of Table 1) with $D = D_{\langle M \rangle}$. On the other hand only the weights $w_2 = |\Delta M|^{-2}$ give a_0 the exact ECM standard value 12.7 at $z \lesssim 0.5$; this means the ECM agrees with the adopted $\langle M \rangle = d_0 + d_1 D_z + d_2 D_z^2$ at that z range. In other words the solutions in Table 1 represent a further successful check of the expansion center model at any Hubble depth of the

supernovae Ia. As an illustration, the dipole diagram of the unweighted test W18 is reported in Appendix Figure 8. This ECM dipole test, referring to the SNe of Table 3abcdefghi with $z \geq 0.5$, is graphically represented by the fitted plot of 149 values of $Y_{W18} = \frac{cz}{D_{\langle M \rangle}} - H_0$ against each corresponding value of $-X_z$ (cf. section 4). Appendix Figure 9 represents the same diagram of 3 normal points $\langle Y \rangle$ versus the corresponding $\langle -X_z \rangle$, which include: 74 SNe at the range $-X_z < 0$; 52 SNe at $0 < -X_z < 0.25$ and 23 SNe at $-X_z > 0.25$.

3.3 ECM dipole test based on $\Delta M \equiv 0$

Within the previous dipole test, when one assumes $M \equiv \langle M \rangle$ or $\Delta M \equiv 0$, eq. (14) immediately leads to the identity $D_{\langle M \rangle} \equiv D_z$, that is a Hubble depth D which should agree with both the ECM Hubble law (1) and the Hubble Magnitude formulation of eq. (10). This is the case of the 1st type dipole test in paper XV, according to the paper IX procedure, here integrated by the ECM formulae and summarized as follows:

$$M - \langle M \rangle = \Delta M \rightarrow 0 \Rightarrow M \equiv \langle M \rangle = d_2 D^2 + d_1 D + d_0 = m - 5 \log D_C - 25 \quad (25)$$

$$D_C = D \cdot (1 + z) \Rightarrow d_2 D^2 + d_1 D + d_0 + 5 \log D = m - 5 \log(1 + z) - 25 \quad (26)$$

$$[z, m, d_0, d_1, d_2 \Rightarrow D] \quad (27)$$

$$D = \frac{xc}{3H_0} \left(\frac{1+x}{1-x} \right) \Rightarrow x = x(D) \Rightarrow X = X(x, \cos \gamma) = X(D, \cos \gamma) \quad (28)$$

$$cz = (H_0 - a_0 X) \cdot D \Rightarrow Y = \left(\frac{cz}{D} - H_0 \right) \Rightarrow Y \rightarrow -X \Rightarrow a_0 \quad (29)$$

Eq. (29) has been checked again on the pilot sample XVI, using all the cz and D values listed in Table 3abcdefghi in the paper IX appendix. The $\cos \gamma$ introduction allows a further ECM dipole test on the same 13 z bins in Table 0. The resulting angular coefficient a_0 of each unweighted dipole test and the corresponding standard deviation s , in H.u., are reported in the last two columns of Table 2; here the first column is the TID names, as the continuation of the A series in paper XV. Also this ECM dipole test based on $\Delta M \equiv 0$, as the results of Table 2 show when compared with those of Table 1, gives evidence for the perturbative ΔM effect at $z \lesssim 0.5$. As in the previous section, Appendix Figure 10 presents the dipole diagram of the test A18, as a plot of Y_{A18} versus $-X$. Appendix Figure 11 represents the same diagram of 3 normal points $\langle Y \rangle$ versus the corresponding $\langle -X \rangle$, which include: 74 SNe at the range $-X < 0$; 52 SNe at $0 < -X < 0.25$ and 23 SNe at $-X > 0.25$.

Table 2

TID	Sample	N	z bin	s	a_0
A11	XVI ₁₁	50	$0.2 < z \leq 0.4$	14.89	-2 ± 6
A12	XVI ₁₂	101	$0.2 < z \leq 0.5$	14.35	-5 ± 5
A13	XVI ₁₃	142	$0.2 < z \leq 0.6$	13.78	-4 ± 4
A14	XVI ₁₄	174	$0.2 < z \leq 0.7$	13.93	0 ± 4
A15	XVI ₁₅	192	$0.2 < z \leq 0.8$	13.62	1 ± 4
A16	XVI ₁₆	215	$0.2 < z \leq 0.9$	13.43	1 ± 4
A0	XVI	249	$0.2 < z < 1.4$	13.15	3 ± 3
A17	XVI ₁₇	200	$0.4 \leq z < 1.4$	12.73	4 ± 4
A18	XVI ₁₈	149	$0.5 \leq z < 1.4$	11.94	9.5 ± 3.6
A19	XVI ₁₉	107	$0.6 \leq z < 1.4$	11.72	13.8 ± 4.2
A20	XVI ₂₀	75	$0.7 \leq z < 1.4$	11.01	9.6 ± 4.8
A21	XVI ₂₁	58	$0.8 \leq z < 1.4$	11.24	11.1 ± 5.6
A1	XVI₁	48	$0.83 \leq z < 1.4$	10.50	12.6 ± 5.8

3.4 The SNe ΔM effect

All the previous dipole tests seem to give ΔM a crucial and macroscopic perturbation role, within the adopted expansion center model. What might be the nature of such a ΔM ? Here, at least two origins have to be taken into account, intrinsic or statistical. While the first has to do with the physics and gravitation of the supernova itself, the latter may be due both to selection effects and limits in the model, which is formally correct when applied to the very nearby Universe with a rigid rotation (cf. paper VII and section 7.4 of paper I). In fact the ECM dipoles were well confirmed in the nearby Universe (cf. papers I-II and also Lorenzi 1991-93), without using supernovae; further confirmation came only from the far Abell clusters, the 66 of Richness 3, at $z \lesssim 0.3$ and $\langle z \rangle \cong 0.2$ (cf. paper V and also Lorenzi 1994). A first successful dipole test on SNe Ia was carried out through two historic and accurate SCP samples, by P99 and K03, at the average redshift $\langle z \rangle = 0.5$ (cf. paper VI). The latest ECM confirmation refers to the Deep Universe, at $0.2 < z \lesssim 1.4$, as shown in this work and in the parallel paper XV. Consequently, the present disagreement of the unweighted SNe dipoles at $z \lesssim 0.5$ is very likely due to the perturbation effect of the SNe ΔM , producing both an intrinsic and statistical interference.

4. ECM values from 249 High- z SCP Union SNe Ia

This section is devoted to presenting 1743 data in Hubble units, calculated for 249 High- z SCP Union supernovae, according to the expansion center model. In particular the first three columns of Table 3abcdefghi list below in order: Supernova name as reported in the 2008 SCP Union paper (*SCPU*: Kowalski et al. 2008); redshift z_{SCP} of supernova or host galaxy as listed in *SCPU*, but rounded off to the third decimal place as the CMB reference affects the value for about 0.001 on average (cf. paper IX); supernova magnitude m_{SCPU} as m_B^{\max} value listed in *SCPU*, without standard deviation. The fourth column holds the calculated value of $-\cos \gamma$, according to eq. (16) of paper XV, after introducing the SNe R.A. α and Decl. δ , those listed in paper XV Table 5abc or in the *SCPU* reference papers (cf. Harvard-IAU, Riess et al. 2007, Astier et al. 2006, Riess et al. 2004, Miknaitis et al. 2007). The following four columns are all dedicated to as many ECM values, here called $r_z, D_z, M_z, -X_z$ in that directly coming from eq. (1) with the ECM standard values $H_0 = 70$ H.u. and $a_0 = 12.7$ H.u. applied. Lastly, the 9th column reports the integer value of the Hubble ratio $\frac{cz}{D_{\langle M \rangle}}$, with $D_{\langle M \rangle}$ calculated through eq. (13), while column 10 lists the crucial value of $\Delta M = M_z - \langle M \rangle$, which represents the ECM scattering of the SN Hubble Magnitude with respect the average value $\langle M \rangle$ of eq. (7).

4.1 Evidence for intrinsic SNe ΔM

Concerning Table 3 below, one can attempt to search for the possible intrinsic nature of some large ΔM . First of all one's attention must fall on those SNe which present very high ΔM , for example $\Delta M \geq +1.0$, as in the case of the following SNe: 03D4au with $\Delta M = +1.03$; g055 with $\Delta M = +1.39$; g142 with $\Delta M = +0.98$; k485 with $\Delta M = +1.26$. Another simple and more powerful procedure is based on the comparison of only a few pairs of supernovae which, with almost the same redshift and position on the celestial sphere, show very different ΔM . To this end we also need to check the SNe coordinates, as the same ECM $\cos \gamma$ refers to the same hemisphere, not necessarily to the same position in the sky. In Table 3 we can find a few of such SNe couples with at least one $\Delta M > 0.5$ and $\Delta(\Delta M) > 0.5$ (as an example we cite the couple 05Zwi-2002hr). The aforementioned evidence for a possible intrinsic origin of many SNe ΔM is very important, in that it appears to represent a crucial proof, in accordance with the expansion center model, against the common assumption of using the supernovae SNe Ia as good standard candles. In particular, at present it results that **the individual SNe Ia are not usable standard candles**.

Table 3a

Name	z_{SCP}	m_{SCPU}	$-\cos\gamma$	r_z	D_z	M_z	$-X_z$	$\frac{cz}{D_{(M)}}$	ΔM
1996h	0.620	23.50	-0.5301	794	2784	-19.77	-0.260	74	-0.23
1996i	0.570	23.40	-0.6082	771	2582	-19.64	-0.305	71	-0.14
1996j	0.300	22.03	-0.6961	583	1388	-19.25	-0.415	67	-0.06
1996k	0.380	22.64	-0.8527	658	1783	-19.32	-0.475	64	-0.02
1996u	0.430	22.61	-0.7171	690	1981	-19.65	-0.388	75	-0.30
1995ao	0.240	21.60	+0.0241	496	1024	-18.92	+0.016	65	+0.17
1995ap	0.300	21.53	-0.0533	562	1292	-19.60	-0.032	85	-0.43
1996t	0.240	20.99	-0.7591	522	1124	-19.73	-0.478	85	-0.61
1997ce	0.440	22.80	-0.0179	675	1886	-19.37	-0.010	71	-0.04
1997cj	0.500	23.14	-0.6772	734	2288	-19.54	-0.352	69	-0.11
1997ck	0.970	24.72	-0.0482	914	4167	-19.85	-0.021	71	-0.04
1995k	0.479	22.72	-0.6764	721	2192	-19.83	-0.356	80	-0.43
1997ap	0.830	24.34	-0.2912	875	3646	-19.78	-0.132	70	-0.06
1997am	0.416	22.46	-0.7253	680	1917	-19.71	-0.396	77	-0.37
1997aj	0.581	23.16	-0.7211	780	2659	-19.96	-0.358	80	-0.44
1997ai	0.450	22.92	-0.7745	705	2081	-19.48	-0.413	68	-0.10
1997af	0.579	23.57	-0.8892	784	2694	-19.57	-0.440	66	-0.05
1997ac	0.320	21.89	-0.8896	609	1515	-19.62	-0.518	76	-0.39
1997r	0.657	23.92	-0.7191	817	3003	-19.56	-0.345	65	+0.03
1997p	0.472	23.13	-0.7214	718	2171	-19.39	-0.380	65	+0.01
1997o	0.374	23.32	-0.8892	654	1760	-18.60	-0.497	46	+0.70
1997h	0.526	23.18	-0.4034	741	2340	-19.58	-0.208	72	-0.14
1997g	0.763	24.37	-0.3989	853	3386	-19.51	-0.184	63	+0.16
1997f	0.580	23.41	-0.3639	770	2573	-19.64	-0.183	72	-0.14
1996cn	0.430	23.22	-0.2871	677	1898	-18.95	-0.157	57	+0.38
1996cm	0.450	23.25	+0.0616	680	1917	-18.97	+0.034	60	+0.36
1996cl	0.828	24.55	-0.7224	885	3772	-19.64	-0.323	63	+0.10
1996ck	0.656	23.77	-0.4630	809	2925	-19.66	-0.224	70	-0.08
1996ci	0.495	22.82	-0.2963	720	2185	-19.75	-0.156	80	-0.35
1996cg	0.490	23.07	-0.8838	734	2288	-19.59	-0.459	69	-0.17

Table 3b

Name	z_{SCP}	m_{SCPU}	$-\cos\gamma$	r_z	D_z	M_z	$-X_z$	$\frac{cz}{D_{(M)}}$	ΔM
1996cf	0.570	23.31	-0.7708	776	2624	-19.76	-0.384	73	-0.26
1995ba	0.388	22.55	-0.9117	666	1831	-19.48	-0.504	68	-0.16
1995az	0.450	22.61	-0.3184	691	1987	-19.69	-0.172	79	-0.34
1995ay	0.480	23.06	-0.0072	702	2060	-19.36	-0.004	70	+0.01
1995ax	0.615	23.22	+0.1194	774	2607	-19.90	+0.060	85	-0.40
1995aw	0.400	22.18	+0.1244	642	1691	-19.69	+0.070	86	-0.42
1995at	0.655	23.22	+0.3761	786	2712	-20.04	+0.186	92	-0.51
1995as	0.498	23.66	+0.3878	701	2054	-18.78	+0.208	55	+0.59
1995ar	0.465	23.37	+0.3899	680	1917	-18.87	+0.213	59	+0.46
1995aq	0.453	23.20	+0.4566	670	1855	-18.95	+0.252	62	+0.37
1994g	0.425	22.34	-0.9019	692	1994	-19.93	-0.487	83	-0.57
1999fw	0.278	21.72	+0.6812	517	1104	-19.03	+0.430	73	+0.08
1999fn	0.477	22.72	-0.3119	709	2108	-19.75	-0.166	80	-0.36
1999fm	0.950	24.30	+0.1006	905	4040	-20.18	+0.044	84	-0.39
1999fk	1.057	24.77	+0.1061	935	4485	-20.05	+0.045	77	-0.19
1999fj	0.816	24.22	+0.1134	860	3466	-19.77	+0.052	74	-0.09
1999ff	0.455	23.21	+0.0936	682	1930	-19.03	+0.051	61	+0.31
2002ad	0.514	23.06	-0.8341	747	2387	-19.73	-0.428	73	-0.28
2002ab	0.423	22.60	-0.8996	691	1987	-19.66	-0.486	73	-0.31
2002aa	0.946	24.60	-0.9007	927	4360	-20.04	-0.385	71	-0.20
2002x	0.859	24.73	-0.9684	901	3984	-19.62	-0.426	60	+0.16
2002w	1.031	24.47	-0.9684	952	4763	-20.46	-0.403	84	-0.55
2001kd	0.936	24.96	-0.9029	924	4315	-19.65	-0.387	60	+0.19
2001jp	0.528	22.89	-0.6266	749	2402	-19.93	-0.321	82	-0.48
2001jn	0.645	24.55	-0.3552	801	2849	-18.80	-0.173	48	+0.75
2001jm	0.978	24.50	-0.3511	923	4300	-20.15	-0.151	79	-0.31
2001jh	0.885	24.31	+0.1137	884	3759	-19.94	+0.051	77	-0.20
2001jf	0.815	25.19	+0.1162	859	3455	-18.80	+0.053	47	+0.89
2001iy	0.568	23.07	-0.8336	777	2633	-20.01	-0.415	81	-0.50
2001ix	0.711	23.80	-0.8348	843	3274	-19.94	-0.390	75	-0.30

Table 3c

Name	z_{SCP}	m_{SCPU}	$-\cos\gamma$	r_z	D_z	M_z	$-X_z$	$\frac{cz}{D_{(M)}}$	ΔM
2001iw	0.340	22.10	-0.3503	608	1510	-19.43	-0.204	74	-0.20
2001iv	0.396	22.47	-0.9022	671	1861	-19.60	-0.497	73	-0.28
2001hy	0.812	24.95	-0.9686	885	3772	-19.22	-0.433	51	+0.52
2001hx	0.799	24.78	-0.9695	881	3721	-19.35	-0.435	54	+0.39
2001hu	0.882	24.91	-0.9007	907	4067	-19.51	-0.393	57	+0.29
2001hs	0.833	24.26	-0.3503	877	3671	-19.88	-0.158	73	-0.16
2001fs	0.874	25.12	-0.3514	891	3850	-19.17	-0.156	52	+0.59
2001fo	0.772	23.75	-0.3449	855	3408	-20.16	-0.159	85	-0.48
2000fr	0.543	23.03	-0.3497	749	2402	-19.82	-0.179	80	-0.36
1998bi	0.750	23.91	-0.2890	845	3296	-19.90	-0.135	76	-0.24
1998be	0.640	23.80	-0.2914	797	2812	-19.52	-0.142	67	+0.03
1998ba	0.430	22.87	-0.3035	677	1898	-19.30	-0.166	67	+0.03
1998ay	0.640	23.72	-0.7253	809	2925	-19.68	-0.350	69	-0.11
1998ax	0.497	23.15	-0.7224	734	2288	-19.52	-0.375	68	-0.12
1998aw	0.440	23.20	-0.7178	698	2027	-19.39	-0.386	58	+0.23
1998as	0.355	22.67	-0.7279	633	1642	-19.07	-0.415	59	+0.20
1997ez	0.780	24.26	-0.8822	871	3597	-19.77	-0.400	67	-0.06
1997eq	0.540	23.16	-0.3936	749	2402	-19.68	-0.201	75	-0.23
1997ek	0.860	24.48	-0.3875	887	3798	-19.77	-0.173	68	-0.02
04Eag	1.020	24.97	-0.6777	943	4613	-19.88	-0.285	66	+0.01
04Gre	1.140	24.73	+0.1253	956	4832	-20.34	+0.052	86	-0.43
04Man	0.854	24.53	-0.6786	892	3863	-19.75	-0.301	66	+0.01
04Mcg	1.370	25.73	+0.1263	1006	5807	-19.96	+0.049	68	+0.07
04Omb	0.975	24.88	+0.1248	912	4163	-19.68	+0.054	67	+0.13
04Pat	0.970	25.02	-0.6762	929	4391	-19.67	-0.288	61	+0.18
04Rak	0.740	23.84	+0.1250	830	3136	-19.84	+0.059	79	-0.23
04Sas	1.390	25.82	-0.6786	1025	6244	-20.05	-0.259	66	+0.03
04Yow	0.460	23.59	-0.6789	709	2108	-18.85	-0.361	51	+0.53
05Fer	1.020	24.83	-0.6789	943	4613	-20.02	-0.285	70	-0.13
05Gab	1.120	25.07	-0.6794	968	5046	-20.08	-0.277	71	-0.13

Table 3d

Name	z_{SCP}	m_{SCPU}	$-\cos\gamma$	r_z	D_z	M_z	$-X_z$	$\frac{cz}{D_{(M)}}$	ΔM
05Lan	1.230	26.02	-0.6783	993	5531	-19.44	-0.269	51	+0.57
05Red	1.190	25.76	-0.6782	985	5369	-19.59	-0.272	55	+0.40
05Spo	0.839	24.20	-0.6779	887	3798	-20.02	-0.302	75	-0.27
05Str	1.010	25.03	-0.6793	940	4564	-19.78	-0.286	64	+0.09
05Zwi	0.521	23.07	+0.1235	723	2207	-19.56	+0.065	76	-0.15
2002dc	0.475	23.09	-0.6785	719	2178	-19.44	-0.357	67	-0.04
2002dd	0.950	24.66	-0.6784	923	4300	-19.96	-0.291	70	-0.12
2002fw	1.300	25.65	+0.1244	992	5510	-19.86	+0.049	66	+0.14
2002hp	1.305	25.41	+0.1250	993	5521	-19.92	+0.050	74	-0.11
2002hr	0.526	24.04	+0.1244	726	2229	-18.62	+0.065	49	+0.79
2002kd	0.735	24.02	+0.1247	828	3115	-19.64	+0.059	72	-0.03
2002ki	1.140	25.35	-0.6770	973	5138	-19.86	-0.275	63	+0.10
2003az	1.265	25.68	-0.6774	1001	5699	-19.87	-0.266	62	+0.15
2003dy	1.340	25.77	-0.6780	1016	6032	-19.98	-0.262	64	+0.08
2003eq	0.840	24.35	-0.6770	888	3811	-19.88	-0.302	70	-0.13
03D4au	0.468	23.86	+0.9334	666	1831	-18.29	+0.516	48	+1.03
04D4bk	0.840	24.31	+0.9345	848	3329	-19.63	+0.434	75	+0.03
04D3nr	0.960	24.54	-0.4827	921	4270	-20.07	-0.208	75	-0.24
04D3lu	0.822	24.34	-0.4872	877	3671	-19.79	-0.220	69	-0.06
04D3ki	0.930	24.87	-0.4885	912	4138	-19.64	-0.212	62	+0.17
04D3gt	0.451	23.23	-0.4829	697	2027	-19.11	-0.260	59	+0.25
04D3do	0.610	23.57	-0.4926	788	2730	-19.64	-0.243	71	-0.11
04D3cp	0.830	24.24	-0.4884	880	3708	-19.92	-0.220	73	-0.19
04D2gp	0.707	24.15	-0.8582	842	3263	-19.58	-0.401	63	+0.06
04D2fp	0.415	22.53	-0.8566	684	1942	-19.67	-0.466	74	-0.32
04D1ag	0.557	23.00	+0.1699	742	2348	-19.82	+0.088	84	-0.37
03D4fd	0.791	24.21	+0.9306	830	3136	-19.54	+0.440	73	+0.08
03D4cz	0.695	24.03	+0.9322	790	2748	-19.31	+0.459	68	+0.22
03D4at	0.633	23.74	+0.9343	761	2499	-19.31	+0.473	70	+0.16
03D3bh	0.249	21.13	-0.4847	523	1128	-19.61	-0.305	83	-0.49

Table 3e

Name	z_{SCP}	m_{SCPU}	$-\cos\gamma$	r_z	D_z	M_z	$-X_z$	$\frac{cz}{D_{(M)}}$	ΔM
03D3af	0.532	23.49	-0.4855	747	2387	-19.33	-0.249	63	+0.13
03D1fc	0.331	21.80	+0.1648	584	1393	-19.54	+0.098	84	-0.35
03D1bp	0.346	22.45	+0.1674	597	1455	-19.01	+0.099	65	+0.20
04D4dw	0.961	24.57	+0.9317	889	3824	-19.80	+0.415	77	-0.05
04D4an	0.613	24.02	+0.9321	751	2418	-18.94	+0.476	60	+0.52
04D3nh	0.340	22.14	-0.4821	613	1536	-19.43	-0.280	73	-0.19
04D3lp	0.983	24.93	-0.4886	928	4376	-19.76	-0.209	65	+0.09
04D3is	0.710	24.26	-0.4963	834	3178	-19.42	-0.234	61	+0.21
04D3fq	0.730	24.13	-0.4947	842	3263	-19.63	-0.231	67	+0.02
04D3df	0.470	23.47	-0.4917	710	2115	-18.99	-0.261	56	+0.39
04D3co	0.620	23.78	-0.4946	793	2775	-19.48	-0.243	65	+0.06
04D2gc	0.521	23.32	-0.8509	752	2426	-19.52	-0.434	66	-0.06
04D2cf	0.369	22.34	-0.8505	649	1731	-19.53	-0.478	72	-0.25
03D4gl	0.571	23.26	+0.9329	729	2250	-19.48	+0.487	78	-0.06
03D4dy	0.604	23.32	+0.9344	746	2379	-19.59	+0.480	81	-0.14
03D4cy	0.927	24.72	+0.9347	878	3683	-19.54	+0.421	69	+0.19
03D4ag	0.285	21.21	+0.9337	517	1104	-19.55	+0.590	95	-0.44
03D3ba	0.291	22.05	-0.4955	568	1319	-19.11	-0.299	64	+0.07
03D1gt	0.548	24.12	+0.1676	737	2310	-18.65	+0.087	50	+0.79
03D1ew	0.868	24.37	+0.1748	876	3659	-19.80	+0.079	74	-0.08
03D1ax	0.496	22.96	+0.1747	706	2088	-19.51	+0.093	76	-0.14
04D4dm	0.811	24.39	+0.9309	838	3220	-19.44	+0.437	69	-0.20
04D3oe	0.756	24.08	-0.4892	852	3374	-19.78	-0.226	71	-0.12
04D3nc	0.817	24.27	-0.4959	875	3646	-19.84	-0.224	71	-0.12
04D3ks	0.752	23.88	-0.4814	850	3352	-19.96	-0.223	77	-0.30
04D3hn	0.552	23.47	-0.4825	758	2474	-19.45	-0.245	66	+0.02
04D3fk	0.358	22.53	-0.4919	628	1614	-19.17	-0.282	64	+0.08
04D3dd	1.010	25.12	-0.4931	936	4500	-19.66	-0.209	61	+0.20
04D2ja	0.741	24.10	-0.8527	856	3420	-19.77	-0.393	68	-0.10
04D2gb	0.430	22.80	-0.8502	694	2007	-19.49	-0.458	68	-0.13

Table 3f

Name	z_{SCP}	m_{SCPU}	$-\cos\gamma$	r_z	D_z	M_z	$-X_z$	$\frac{cz}{D_{(M)}}$	ΔM
04D1ak	0.526	23.63	+0.1596	725	2221	-19.02	+0.084	59	+0.39
03D4gg	0.592	23.40	+0.9331	740	2333	-19.45	+0.482	76	-0.01
03D4di	0.905	24.29	+0.9334	871	3597	-19.89	+0.423	82	-0.18
03D4cx	0.949	24.50	+0.9333	885	3772	-19.83	+0.417	79	-0.09
03D3cd	0.461	22.56	-0.4916	704	2074	-19.85	-0.263	83	-0.47
03D3ay	0.371	22.20	-0.4928	639	1675	-19.60	-0.279	77	-0.33
03D1fq	0.800	24.52	+0.1617	853	3386	-19.40	+0.075	63	+0.26
03D1co	0.679	24.10	+0.1696	803	2868	-19.31	+0.082	63	+0.25
03D1aw	0.582	23.59	+0.1735	755	2450	-19.35	+0.088	68	+0.11
04D4bq	0.550	23.36	+0.9345	717	2164	-19.27	+0.493	72	+0.13
04D3ny	0.810	24.27	-0.4896	872	3609	-19.81	-0.222	70	-0.09
04D3ml	0.950	24.55	-0.4976	919	4240	-20.04	-0.215	74	-0.21
04D3kr	0.337	21.97	-0.4959	611	1525	-19.58	-0.288	78	-0.35
04D3gx	0.910	24.71	-0.4870	906	4053	-19.73	-0.213	65	+0.06
04D3ez	0.263	21.68	-0.4920	539	1193	-19.21	-0.305	68	-0.07
04D3cy	0.643	23.80	-0.4928	804	2877	-19.57	-0.239	67	-0.01
04D2iu	0.691	24.26	-0.8556	835	3188	-19.40	-0.403	58	+0.23
04D2fs	0.357	22.42	-0.8512	639	1675	-19.36	-0.482	67	-0.09
04D1aj	0.721	23.90	+0.1714	821	3043	-19.70	+0.082	74	-0.10
03D4gf	0.581	23.35	+0.9341	734	2288	-19.44	+0.485	77	-0.01
03D4dh	0.627	23.39	+0.9300	758	2474	-19.63	+0.472	82	-0.16
03D4cn	0.818	24.65	+0.9297	840	3242	-19.20	+0.435	62	+0.44
03D3aw	0.449	22.55	-0.4865	696	2020	-19.78	-0.262	81	-0.42
03D1fl	0.688	23.63	+0.1638	807	2906	-19.82	+0.079	80	-0.25
03D1cm	0.870	24.46	+0.1699	877	3671	-19.72	+0.077	71	+0.001
03D1au	0.504	22.98	+0.1697	711	2122	-19.54	+0.090	76	-0.15
b010	0.591	23.40	+0.1807	760	2490	-19.59	+0.092	75	-0.11
b013	0.426	22.68	+0.1816	659	1789	-19.35	+0.101	73	-0.05
b016	0.329	22.50	+0.7603	564	1301	-18.69	+0.461	61	+0.48
d033	0.531	23.23	+0.7700	710	2115	-19.32	+0.409	73	+0.06

Table 3g

Name	z_{SCP}	m_{SCPU}	$-\cos\gamma$	r_z	D_z	M_z	$-X_z$	$\frac{cz}{D_{(M)}}$	ΔM
d058	0.583	23.59	+0.4062	749	2402	-19.31	+0.208	68	+0.14
d084	0.519	23.64	+0.1955	720	2185	-18.97	+0.103	58	+0.44
d085	0.401	22.48	+0.7611	624	1593	-19.26	+0.437	76	-0.01
d087	0.340	21.91	+0.3942	585	1397	-19.45	+0.235	82	-0.26
d089	0.436	22.50	+0.1884	666	1831	-19.60	+0.104	81	-0.29
d093	0.363	21.89	+0.1865	611	1525	-19.70	+0.108	89	-0.47
d097	0.436	22.50	+0.1794	667	1837	-19.61	+0.099	81	-0.29
d117	0.309	22.36	+0.1837	563	1296	-18.79	+0.111	60	+0.38
d149	0.342	22.19	+0.2222	592	1431	-19.23	+0.131	72	-0.02
e029	0.332	22.52	+0.3917	578	1364	-18.78	+0.235	60	+0.41
e108	0.469	22.55	+0.1904	689	1974	-19.76	+0.103	86	-0.41
e132	0.239	21.70	+0.2211	489	999	-18.76	+0.143	62	+0.32
e136	0.352	22.80	+0.2161	601	1475	-18.70	+0.127	56	+0.52
e138	0.612	24.05	+0.1726	771	2582	-19.05	+0.087	58	+0.45
e140	0.631	23.39	+0.1791	780	2659	-19.80	+0.089	81	-0.28
e147	0.645	23.38	+0.1832	787	2721	-19.87	+0.090	83	-0.35
e148	0.429	22.65	+0.1816	662	1807	-19.41	+0.101	75	-0.10
e149	0.497	22.90	+0.1808	707	2094	-19.58	+0.096	78	-0.20
f011	0.539	23.29	+0.2290	730	2258	-19.41	+0.119	71	+0.005
f041	0.561	23.09	+0.4021	738	2318	-19.70	+0.208	82	-0.27
f076	0.410	22.37	+0.4102	641	1686	-19.51	+0.232	81	-0.24
f096	0.412	23.06	+0.7677	632	1636	-18.76	+0.438	60	+0.50
f216	0.599	23.75	+0.1613	765	2531	-19.29	+0.081	65	+0.20

Table 3h

Name	z_{SCP}	m_{SCPU}	$-\cos \gamma$	r_z	D_z	M_z	$-X_z$	$\frac{cz}{D_{(M)}}$	ΔM
f231	0.619	23.45	+0.7531	759	2482	-19.57	+0.382	78	-0.10
f235	0.422	22.45	+0.3897	650	1737	-19.51	+0.219	81	-0.23
f244	0.540	23.30	+0.1861	732	2273	-19.42	+0.097	71	+0.003
f308	0.401	23.07	+0.1891	641	1686	-18.80	+0.107	57	+0.48
g005	0.218	21.32	+0.7577	447	855	-18.77	+0.509	67	+0.27
g050	0.633	23.18	+0.7625	765	2531	-19.90	+0.384	91	-0.42
g052	0.383	22.33	+0.7678	609	1515	-19.28	+0.447	77	-0.05
g055	0.302	23.28	+0.3891	550	1239	-17.76	+0.239	38	+1.39
g097	0.340	22.27	+0.7661	574	1346	-19.01	+0.460	70	+0.17
g120	0.510	22.79	+0.3830	709	2108	-19.72	+0.204	85	-0.34
g133	0.421	23.17	+0.2240	655	1766	-18.83	+0.125	58	+0.47
g142	0.399	23.46	+0.7582	622	1583	-18.27	+0.436	48	+0.98
g160	0.493	22.92	+0.1835	704	2074	-19.53	+0.098	77	-0.16
g240	0.687	23.40	+0.7523	791	2757	-19.94	+0.370	90	-0.40
h283	0.502	23.45	+0.2496	708	2101	-19.05	+0.133	61	+0.34
h300	0.687	23.52	+0.1821	806	2896	-19.92	+0.088	84	-0.36
h319	0.495	22.90	+0.2300	704	2074	-19.56	+0.123	78	-0.18
h323	0.603	23.48	+0.1851	766	2540	-19.57	+0.093	74	-0.08
h342	0.421	22.44	+0.1800	656	1771	-19.56	+0.100	81	-0.27
h359	0.348	22.65	+0.2364	597	1455	-18.81	+0.139	60	+0.40
h363	0.213	22.01	+0.2404	457	887	-18.15	+0.160	48	+0.90
h364	0.344	21.71	+0.1887	595	1445	-19.73	+0.111	91	-0.52
k396	0.271	21.84	+0.7610	507	1065	-18.82	+0.485	67	+0.28

Table 3i

Name	z_{SCP}	m_{SCPU}	$-\cos \gamma$	r_z	D_z	M_z	$-X_z$	$\frac{cz}{D_{(M)}}$	ΔM
k411	0.564	22.89	+0.7643	729	2250	-19.84	+0.399	91	-0.42
k425	0.274	21.94	+0.3917	522	1124	-18.84	+0.246	64	+0.28
k430	0.582	23.81	+0.3826	750	2410	-19.10	+0.196	61	+0.36
k441	0.680	23.73	+0.2204	802	2858	-19.68	+0.107	75	-0.12
k448	0.401	23.34	+0.4038	634	1647	-18.48	+0.230	51	+0.79
k485	0.416	23.93	+0.2254	651	1742	-18.03	+0.126	40	+1.26
m027	0.286	22.52	+0.4012	534	1172	-18.37	+0.250	52	+0.76
m062	0.314	21.99	+0.3950	561	1287	-19.15	+0.240	73	+0.01
m138	0.581	23.28	+0.3977	749	2402	-19.62	+0.204	78	-0.16
m158	0.463	23.09	+0.7727	668	1843	-19.06	+0.427	67	+0.25
m193	0.341	21.66	+0.1832	592	1431	-19.76	+0.108	92	-0.55
m226	0.671	23.64	+0.2419	797	2812	-19.72	+0.118	77	-0.17
n256	0.631	23.41	+0.1867	780	2659	-19.78	+0.093	80	-0.26
n258	0.522	23.29	+0.2372	720	2185	-19.32	+0.125	69	+0.08
n263	0.368	22.04	+0.2473	613	1536	-19.57	+0.143	84	-0.34
n278	0.309	21.87	+0.7633	545	1218	-19.14	+0.471	76	+0.002
n285	0.528	23.27	+0.7664	709	2108	-19.27	+0.407	71	+0.11
n326	0.268	22.11	+0.7561	504	1054	-18.52	+0.483	58	+0.58
p454	0.695	23.93	+0.2235	808	2915	-19.54	+0.108	70	+0.03
p455	0.284	21.66	+0.2195	538	1189	-19.26	+0.136	76	-0.12
p524	0.508	22.91	+0.1883	713	2136	-19.63	+0.100	80	-0.24
p528	0.781	24.12	+0.2281	844	3285	-19.72	+0.106	74	-0.07
p534	0.613	23.40	+0.2389	770	2573	-19.69	+0.120	78	-0.20

5. A new ECM dipole test

All the ECM papers, V, VI, IX, XV, and the previous sections of paper XVI, have been developed by assuming the identity $D_C = D(1+z) \equiv D_L$. As the Hubble depth D represents an apparent distance at the present epoch t_0 (cf. paper XV), so the related D_L should be a fictitious luminous distance D_{FL} , according to the arguments in paper V. Consequently the resulting successful M , called Hubble Magnitude in paper X and XV, may be different from the true absolute magnitude, though the formula

$$M = m - 5 \log D_L - 25 \quad (30)$$

might make the necessary adjustment between the apparent magnitude m and the apparent distance D_L in order to produce the correct value of the absolute magnitude M . This is the problem: what luminosity distance D_L is able to produce, not just a useful but likely fictitious value of M , but the true M ? The present section proposes the ECM **exploration of the following D_L^* formula**:

$$D_L^* = r \cdot (1+z)^2 \quad (31)$$

The previous D_L^* equation differs from relativistic cosmology in that, here, the light-space $r = -c\Delta t$ is a physical distance, representing the space run by light during the past travel time $\Delta t = t - t_0$, in place of the relativistic proper distance r_{pr} at the emission epoch t (cf. section 2 of papers VIII, IX, XV). However r in light-time also represents a measure of the past epoch t ; in other words r may be considered to all intents and purposes the light-space distance of the source at time t . That r , as r_z , is the light space fitting the ECM Hubble law (1). In this case the proposed experimental formulation of the luminosity distance is eq. (31), here explored and tested on 249 High-z SCP Union supernovae, both to check the behaviour of the SNe Ia absolute magnitude according to the expansion center model, where now the High-z SNe Ia show low and slowly increasing average absolute magnitudes $\langle M^* \rangle$, and to **reconfirm the expansion dipole** of the ECM Universe - with $\langle M^* \rangle \cong -18.01$ from all 249 SNe - $\langle M^* \rangle \cong -18.02$ from 200 SNe at $z \geq 0.4$ - $\langle M^* \rangle \cong -18.03$ from 149 SNe at $z \geq 0.5$ -.

The ECM test of eq. (31) is based on the 13 ECM normal points of the corresponding samples in Table 0, here partially reproduced in Table 4, with two new columns, $\langle r_z \rangle$ and the $\langle M^* \rangle$ resulting from the data of Table 3abcdefghi, as the sequence (32) reported below shows:

$$\text{ECM : } r = r_z \Rightarrow D_L^* \equiv r_z(1+z)^2 \Rightarrow \langle M^* \rangle = \langle m_B^{\max} \rangle - 5 \langle \log D_L^* \rangle - 25 \quad (32)$$

The linear fitting of the 13 normal $\langle M^* \rangle$ values of Table 4 versus the corresponding $\langle z \rangle$ listed in column 4th gives the resulting relationship (33):

$$\langle M^* \rangle = -17.83(\pm 0.01) - 0.15(\pm 0.02) \cdot \langle z \rangle \quad (33)$$

Hence a 2nd type dipole test (cf. section 3.2 of paper XV) based on eq. (31) has been carried out through the following sequential steps:

$$M^* = m - 5 \log [r \cdot (1+z)^2] - 25 \Rightarrow r = 10^{0.2(m-M^*)-5}/(1+z)^2 \quad (34)$$

$$\text{ECM : } x = \frac{3H_0 r}{c} \Rightarrow D = r \cdot \left(\frac{1+x}{1-x} \right) \Rightarrow Y = \frac{cz}{D} - H_0 = -\cos \gamma \cdot a^*(x) \quad (35)$$

$$[\gamma, z, m, M^*(s_{Min})] \Rightarrow r = \frac{10^{0.2[m-M^*(s_{Min})]-5}}{(1+z)^2} \Rightarrow Y \rightarrow -\cos \gamma \Rightarrow a^* \quad (36)$$

$$a^*(x) = a_0 \cdot (1-x)^{\frac{1}{3}}/(1+x) \Rightarrow X = \cos \gamma \cdot (1-x)^{\frac{1}{3}}/(1+x) \Rightarrow Y \rightarrow -X \Rightarrow a_0 \quad (37)$$

The least square procedure has been applied to all the 13 samples of Table 4. The obtained solutions of the unweighted fittings (36) and (37) are listed in Table 5, for each new double dipole test **R** whose TID number refers to the sample index of Table 4 column 1. The corresponding rows present the resulting angular coefficients $a^*(x)$ and a_0 , preceded by the minimum value of the fitting standard deviations s_{Min} and the related values $M^*(s_{Min})$, following the same order as in Table 3 of paper V. In particular the expected value a_{ECM}^* in column 2 derives from the $a^*(x)$ formula of (37) with $x = 3H_0 \langle r \rangle / c$, $H_0 = 70$ and $a_0 = 12.7$ H.u. (cf. section 2.1), being $\langle r \rangle$ the computed mean light distance of the sample according to (36). The results of this new dipole test are important, though the **standard deviations s_{Min} have here more than doubled**. The test gives a further ECM confirmation. Three large sets of High-z SNe Ia of Table 5, the samples called **XVI -XVI₁₇-XVI₁₈**, produce angular coefficients in accordance with those expected. Moreover the mathematical means of all the 13 a^* and a_0 values listed in Table 5 become $\langle a^*(x) \rangle = +6.1 \pm 2.2$ and $\langle a_0 \rangle = +11.6 \pm 3.8$, respectively, being $\langle a_{ECM}^* \rangle = +6.1 \pm 0.2$ H.u.. Thus the present test, when compared with the previous ones based on $D_L = D \cdot (1+z)$ (cf. also the papers V-VI-IX-XV), clearly shows the ECM dipole check as being independent from the inferred value of M , within the limits of consistent formulations of the luminosity distance D_L . As in the section 3.2 and 3.3, Appendix Figure 12 presents the dipole diagram of the test **R18**, as a plot of Y_{R18} versus $-X$. Appendix Figure 13 represents the same diagram of 3 normal points $\langle Y \rangle$ versus the corresponding $\langle -X \rangle$, which include : 74 SNe at the range $-X < 0$; 52 SNe at $0 < -X < 0.25$ and 23 SNe at $-X > 0.25$.

Table 4

Sample	N	z bin	$\langle z \rangle$	$\langle m \rangle$	$\langle D_z \rangle$	$\langle r_z \rangle$	$\langle M^* \rangle$
XVI ₁₁	50	$0.2 < z \leq 0.4$	0.322	22.123	1425	577.6	-17.883
XVI ₁₂	101	$0.2 < z \leq 0.5$	0.387	22.534	1716	632.1	-17.869
XVI ₁₃	142	$0.2 < z \leq 0.6$	0.434	22.762	1893	663.5	-17.885
XVI ₁₄	174	$0.2 < z \leq 0.7$	0.472	22.928	2037	686.3	-17.902
XVI ₁₅	192	$0.2 < z \leq 0.8$	0.499	23.040	2152	701.3	-17.907
XVI ₁₆	215	$0.2 < z \leq 0.9$	0.535	23.195	2332	720.1	-17.902
XVI	249	$0.2 < z < 1.4$	0.607	23.440	2651	750.4	-17.918
XVI₁₇	200	$0.4 \leq z < 1.4$	0.677	23.763	2951	793.0	-17.928
XVI₁₈	149	$0.5 \leq z < 1.4$	0.756	24.052	3282	830.4	-17.951
XVI ₁₉	107	$0.6 \leq z < 1.4$	0.837	24.339	3658	865.6	-17.961
XVI ₂₀	75	$0.7 \leq z < 1.4$	0.919	24.627	4075	898.9	-17.954
XVI ₂₁	58	$0.8 \leq z < 1.4$	0.969	24.784	4323	914.4	-17.948
XVI ₁	48	$0.83 \leq z < 1.4$	1.001	24.836	4409	924.9	-17.993

Table 5

TID	a_{ECM}^*	s_{Min}	$M^*(s_{Min})$	$a^*(x)$	s_{Min}	$M^*(s_{Min})$	a_0
R11	+7.3	23.190	-18.02	-2 ± 6	23.209	-18.01	-2 ± 10
R12	+6.9	23.157	-17.98	-4 ± 5	23.202	-17.98	-5 ± 8
R13	+6.8	22.313	-17.99	-3 ± 4	22.346	-17.99	-4 ± 7
R14	+6.6	22.662	-18.01	$+1 \pm 3$	22.654	-18.01	$+2 \pm 6$
R15	+6.5	22.372	-18.01	$+1.7 \pm 2.9$	22.368	-18.01	$+3.7 \pm 5.6$
R16	+6.4	22.551	-17.99	$+2.8 \pm 2.8$	22.562	-17.99	$+4.9 \pm 5.4$
R0	+6.2	22.908	-18.01	$+4.6 \pm 2.6$	22.964	-18.01	$+7.3 \pm 5.2$
R17	+6.0	22.794	-18.02	$+6.6 \pm 2.9$	22.887	-18.01	$+11.1 \pm 6.1$
R18	+5.8	22.134	-18.03	$+10.0 \pm 3.1$	22.345	-18.02	$+18.2 \pm 6.9$
R19	+5.5	22.440	-18.04	$+14 \pm 4$	22.823	-18.04	$+29 \pm 9$
R20	+5.3	22.697	-18.05	$+15 \pm 5$	23.298	-18.03	$+25 \pm 11$
R21	+5.2	24.072	-18.04	$+14 \pm 6$	24.644	-18.03	$+25 \pm 13$
R1	+5.2	21.701	-18.08	$+19 \pm 6$	22.746	-18.07	$+35 \pm 14$

6. Absolute magnitude analysis of the SCP Union supernovae

After the preliminary magnitude analysis on the SCP Union data set in paper IX, here a further more precise analysis is carried out so as to distinguish the normal luminosity behaviour of the supernovae Ia of the deep Universe from the SNe magnitude trend of the nearby Universe.

6.1 Fitting 14 High- z SNe M normal points

In the above sections we found evidence for a clear perturbation effect of the SNe ΔM at $z \lesssim 0.5$. In order to avoid possible interference effects, here a new model independent analysis of the normal points in paper IX Table 2 is undertaken and limited to 14 high- z mean Hubble Magnitudes $\langle M \rangle$, those with z -bin normal redshifts $\langle z \rangle > 0.55$. If a first, second and third degree polynomial is applied to the fitting of the $\langle M \rangle$ plot versus $\langle z \rangle$, the statistical coefficients of determination \mathbf{R}^2 are 0.9720, 0.9967, 0.9974, respectively. The best fitting is clearly the cubic one. Therefore, after adopting the identity between the z -bin normal redshift and the central redshift z_0 , that is

$$\langle z \rangle \equiv z_0 \quad (38)$$

and the **normal equation of the Hubble Magnitude**

$$\langle M \rangle = \langle m_B^{\max} \rangle - 5 \langle \log [cz(1+z)] \rangle + 5 \log H_0 - 25 \quad (39)$$

the **line equation of the normal Hubble Magnitude $\langle M \rangle$ as a function of the central redshift z_0** becomes

$$\langle M \rangle = A_0 + A_1 z_0 + A_2 z_0^2 + A_3 z_0^3 \quad (40)$$

with

$$A_0 = -17.96 \quad A_1 = -4.117 \quad A_2 = +3.197 \quad A_3 = -0.9463 \quad (41)$$

from the automatic cubic fitting (cf. Appendix Figure 14) whose coefficient of determination $\mathbf{R}^2 = 0.9974$.

Note that the previous eq. (2) of the normal points $\langle M \rangle$ is the same normal M equation (21) of paper IX, while the Hubble Magnitude M of an individual source with redshift z and apparent magnitude m is by definition

$$M = m - 5 \log [D \cdot (1+z)] - 25 \quad (42)$$

where $D = cz/H_X = cz_0/H_0$ is the Hubble depth according to the expansion center Universe (cf. the ECM papers V-VI-IX-XV).

Together with the successful cubic fitting (3) of 14 high- z normal Hubble Magnitudes $\langle M \rangle$ versus the normal redshift $\langle z \rangle$, it is possible to carry out a successful linear fitting of the same 14 $\langle M \rangle$ points versus the corresponding central light space values $r = r(z_0)$ listed in column 8 of paper IX Table 2. In this case the normal Hubble Magnitude $\langle M \rangle$ is represented by the equation

$$\langle M \rangle = C_0 + C_1 r \quad (43)$$

with

$$C_0 = -17.80 \quad C_1 = -0.002200 \quad (44)$$

from the automatic linear fitting (cf. Appendix Figure 2) whose coefficient of determination $\mathbf{R}^2 = 0.9951$.

The result of the two fittings can be summarized as follows:

$$M_0 \cong \langle M \rangle(z_0 \rightarrow 0) = A_0 \cong \langle M \rangle(r \rightarrow 0) = C_0 \quad (45)$$

Of course M_0 represents the absolute magnitude of a hypothetical supernova Ia with a central redshift $z_0 \rightarrow 0$. As the Hubble Magnitude M is clearly an apparent absolute magnitude at increasing Hubble depths, so its standard value for $D \rightarrow 0$ must necessarily coincide with the true intrinsic absolute magnitude, that is M_α (cf. paper XV).

The conclusion of the preliminary analysis of the SNe Ia absolute magnitudes, based on the high- z normal points with $\langle z \rangle > 0.55$ of the paper IX Table 2, leads to the new result

$$M_0 = \langle M_\alpha \rangle(z_0 \rightarrow 0) \cong -17.9 \quad (46)$$

The previous M_0 value agrees with the new absolute magnitudes $\langle M^* \rangle$ of section 5, those listed in Table 4, that is with the contents in the ADDENDUM NOTE - October 2011 - of paper XI.

6.2 Construction of 30 new normal points from 398 *SCPU* SNe data

The normal points of paper IX Table 2 refer to excessively large z -ranges to be able to represent accurately the SNe Hubble Magnitude trend at the low redshifts of the nearby Universe. Therefore, in order to improve the analysis, we need smaller z bins. The following Table 6 and Table 7, referring to the nearby and deep Universe respectively, collect 30 new normal points, based on 398 *SCPU* supernovae. These two tables were constructed according to the same procedure as paper IX Table 2. In particular the first 5 columns both of Table 6 and Table 7 contain numerical values derived from the observed z and m_B^{\max} listed within the *SCPU* compilation (Kowalski et al.

2008); the values referring to each z bin are in the order: z range; number N of the SNe included in the normal point; unweighted mathematical mean $\langle m \rangle$ of the corresponding SNe magnitudes m_B^{\max} ; mean Hubble Magnitude $\langle M \rangle$ resulting from the normal eq. (2) applied to the bin, with $H_0 = 70$ assumed; mathematical mean of the observed redshifts of the z bin, according to the position $\langle z \rangle \equiv z_0$ of eq. (1). The 6th column holds the value of the **Hubble Magnitude of a supernova Ia**, with $z = \langle z \rangle \equiv z_0$ and $m = \langle m \rangle \equiv m_0$ assumed (cf. paper XV), according to the paper IX formula (19) (also called ECM $M(z_0)$ equation):

$$M(z_0) = m_0 - 5 \log [cz_0 \cdot (1 + z_0)] + 5 \log H_0 - 25 \quad (47)$$

Fitting the points $M(z_0)$ plotted versus z_0 or $r(z_0)$ leads to the **line equation, $M(z_0)$ or $M(r)$, representing the central Hubble Magnitude of the supernovae Ia.**

The last two columns, 7th and 8th, include two other **central quantities**, the light space $r(z_0)$ and the new absolute magnitude $M^*(z_0)$, corresponding to the assumed central redshift $z_0 \equiv \langle z \rangle$ and the central magnitude $m_0 \equiv \langle m \rangle$. Let us recall the ECM calculation procedure of $r(z_0)$, that applied in section 2.1 of paper IX and section 4 of paper XV:

$$z_0 = \frac{x}{3} \left(\frac{1+x}{1-x} \right) \Rightarrow x = x(z_0) = \frac{3H_0 r(z_0)}{c} \Rightarrow r(z_0) = \frac{cx(z_0)}{3H_0} \quad (48)$$

According to eq. (31), the previous $r(z_0)$, whose values are listed in column 7th of Table 6 and 7, allow the introduction of a **new central luminosity distance**, that is

$$D_L^*(z_0) = r(z_0) \cdot (1 + z_0)^2 \quad (49)$$

together with the **new absolute magnitude of a supernova Ia**, always with $z = \langle z \rangle \equiv z_0$ and $m = \langle m \rangle \equiv m_0$ assumed, as follows:

$$M^*(z_0) = m_0 - 5 \log [r(z_0) \cdot (1 + z_0)^2] - 25 \quad (50)$$

Fitting the points $M^*(z_0)$ plotted versus z_0 or $r(z_0)$ leads to the **line equation, $M^*(z_0)$ or $M^*(r)$, representing the new central absolute magnitude of the supernovae Ia.**

Table 6

z range	N	$\langle m \rangle$	$\langle M \rangle$	$\langle z \rangle \equiv z_0$	$M(z_0)$	$r(z_0)$	$M^*(z_0)$
$0 < z \leq 0.010$	16	14.24	-18.14 ± 0.36	0.007	-18.24	29	-18.09
$0 < z \leq 0.015$	33	14.60	-18.44 ± 0.21	0.010	-18.58	40	-18.48
$0.005 \leq z \leq 0.020$	50	14.99	-18.63 ± 0.11	0.013	-18.75	52	-18.64
$0.010 \leq z \leq 0.025$	45	15.46	-18.75 ± 0.11	0.016	-18.81	63	-18.60
$0.015 \leq z \leq 0.030$	40	15.90	-18.86 ± 0.10	0.021	-18.92	80	-18.72
$0.020 \leq z \leq 0.050$	39	16.63	-19.07 ± 0.06	0.032	-19.14	116	-18.84
$0.025 \leq z \leq 0.100$	42	17.19	-19.14 ± 0.05	0.044	-19.28	152	-18.91
$0.030 \leq z \leq 0.150$	37	17.77	-19.15 ± 0.05	0.059	-19.38	193	-18.90
$0.035 \leq z \leq 0.200$	39	18.42	-19.16 ± 0.05	0.083	-19.51	250	-18.91
$0.040 \leq z \leq 0.250$	42	19.50	-19.09 ± 0.06	0.129	-19.48	340	-18.68
$0.045 \leq z \leq 0.300$	52	20.04	-19.09 ± 0.06	0.163	-19.51	395	-18.60
$0.050 \leq z \leq 0.350$	66	20.81	-19.15 ± 0.06	0.220	-19.49	473	-18.43
$0.10 \leq z \leq 0.40$	74	21.80	-19.13 ± 0.06	0.291	-19.24	552	-18.02
$0.15 \leq z \leq 0.45$	100	22.20	-19.18 ± 0.05	0.341	-19.26	598	-17.96
$0.20 \leq z \leq 0.50$	120	22.51	-19.21 ± 0.05	0.382	-19.26	632	-17.90

Table 7

z range	N	$\langle m \rangle$	$\langle M \rangle$	$\langle z \rangle \equiv z_0$	$M(z_0)$	$r(z_0)$	$M^*(z_0)$
$0.25 \leq z \leq 0.55$	131	22.72	-19.26 ± 0.04	0.419	-19.31	660	-17.90
$0.30 \leq z \leq 0.60$	142	22.87	-19.32 ± 0.04	0.450	-19.36	682	-17.91
$0.35 \leq z \leq 0.65$	143	23.10	-19.37 ± 0.04	0.495	-19.40	711	-17.90
$0.40 \leq z \leq 0.70$	138	23.25	-19.44 ± 0.04	0.533	-19.47	733	-17.93
$0.45 \leq z \leq 0.75$	118	23.43	-19.48 ± 0.04	0.574	-19.51	756	-17.93
$0.50 \leq z \leq 0.80$	98	23.61	-19.55 ± 0.04	0.623	-19.57	781	-17.96
$0.55 \leq z \leq 0.85$	91	23.82	-19.60 ± 0.04	0.680	-19.62	808	-17.97
$0.60 \leq z \leq 0.90$	79	24.03	-19.62 ± 0.04	0.730	-19.64	829	-17.94
$0.65 \leq z \leq 0.95$	68	24.25	-19.68 ± 0.04	0.797	-19.69	855	-17.96
$0.70 \leq z \leq 1.00$	62	24.42	-19.71 ± 0.04	0.851	-19.72	875	-17.96
$0.75 \leq z \leq 1.10$	60	24.52	-19.74 ± 0.04	0.885	-19.75	886	-17.97
$0.80 \leq z \leq 1.20$	56	24.62	-19.79 ± 0.05	0.927	-19.80	900	-18.00
$0.85 \leq z \leq 1.30$	44	24.77	-19.86 ± 0.06	0.996	-19.88	921	-18.05
$z \geq 0.9$	43	25.01	-19.88 ± 0.06	1.082	-19.91	944	-18.05
$z \geq 0.95$	34	25.13	-19.89 ± 0.07	1.123	-19.92	955	-18.04

Formally eq. (50) of $M^*(z_0)$ (whose high- z values are listed in column 8th of the above Table 7) is different from eq. (32) of $\langle M^* \rangle$ (whose high- z values are listed in column 8th of Table 4), that is the **normal equation of the new absolute magnitude**, here rewritten in eq. (51),

$$\langle M^* \rangle = \langle m \rangle - 5 \langle \log [r_z(1+z)^2] \rangle - 25 \quad (51)$$

where r_z is the light space resulting from the **ECM z equation** (cf. eq. (4) of paper IX).

Fitting the normal points $\langle M^* \rangle$ plotted versus z_0 or $\langle r_z \rangle$ leads to the **line equation**, $\langle M^* \rangle(z_0)$ or $\langle M^* \rangle(\langle r_z \rangle)$, **representing the new normal absolute magnitude of the supernovae Ia**.

Numerically, we find a small difference between $\langle M^* \rangle$ and $M^*(z_0)$, about 0.03 magnitudes on average at high z , that is

$$\langle M^* \rangle(z_0) - M^*(z_0) \approx 0.03 \quad (52)$$

Thus the usefulness of the new central absolute magnitude $M^*(z_0)$ is confirmed.

6.3 Plotting 30 values of SNe $\langle M \rangle$, $M(z_0)$, $M^*(z_0)$ versus z_0 and $r(z_0)$

The 30 values of $\langle M \rangle$, $M(z_0)$, $M^*(z_0)$ in Table 6 and 7 from *SCPU* data of 398 SNe allow the construction of the corresponding 6 plots, versus $z_0 \equiv \langle z \rangle$ and $r(z_0)$ respectively. These diagrams appear in the Appendix "Atlas of the ECM paper XVI figures". In particular Appendix Figure 16 presents the plot of 30 SNe Ia normal Hubble Magnitudes $\langle M \rangle$ versus the mean redshift $\langle z \rangle$, Appendix Figure 17 the plot of 30 SNe Ia normal Hubble Magnitudes $\langle M \rangle$ versus the ECM $r(z_0)$, Appendix Figure 18 the plot of 30 SNe Ia central Hubble Magnitudes $M(z_0)$ versus z_0 , Appendix Figure 19 the plot of 30 SNe Ia central Hubble Magnitudes $M(z_0)$ versus the ECM $r(z_0)$, Appendix Figure 20 the plot of 30 SNe Ia central absolute magnitudes $M^*(z_0)$ versus z_0 , Appendix Figure 21 the plot of 30 SNe Ia central absolute magnitudes $M^*(z_0)$ versus the ECM $r(z_0)$.

6.4 The magnitude anomaly of the SNe Ia at low $\langle z \rangle$

Even at first sight the plots of the Appendix Figures 16-17-18-19-20-21 highlight the magnitude anomaly of the low $\langle z \rangle$ points. In other words these six diagrams give clear empirical evidence for the normal luminosity behaviour of the supernovae Ia of the deep Universe in comparison with the SNe magnitude trend of the nearby Universe. Such a distinction has been emphasized through the separation of the 30 normal points into two groups of 15 points each. Table 6 collects 15 normalized-central supernovae Ia, which appear to be affected by the magnitude anomaly, with individual redshifts $z \leq 0.5$, while Table 7 collects other 15 normalized-central supernovae Ia based on individual redshifts $z \geq 0.25$. In particular it is remarkable to see in Appendix Figure 20 a significant linear trend (almost constant) of the central absolute magnitudes $M^*(z_0)$ after high normal redshifts, with $\langle z \rangle \gtrsim 0.4$. Thus a preliminary cut-off redshift limit between the nearby Universe affected by the magnitude anomaly and the unperturbed deep Universe is here fixed at $z = 0.25$ and corresponding $\langle z \rangle > 0.4$. But the discovered variation of the SNe Ia luminosity may be only apparent, because there is no astrophysical explanation able to reproduce intrinsically the observed maximum peak in the depth range $0.04 \lesssim \langle z \rangle \lesssim 0.08$, with a resulting $\Delta M \approx 1$ (cf. Appendix Figures 16-18-20).

6.5 Astronomical evidence for cosmic rotation

An interpretation of the observed magnitude anomaly can be found in paper VII "Cosmic mechanics of the nearby Universe within the expansion center model with angular momentum conserved".

In other words the negative collapse of the SNe M at $\langle z \rangle \approx 0.06$ and $\langle z \rangle \equiv z_0 \lesssim 0.4$ is here considered to be a proof of cosmic rotation, which not even the ECM Hubble law (cf. section 2.1 and papers V-VI-IX) includes. Consequently the related magnitude formula, owing to the inclusion of distorted Hubble depths $D = cz_0/H_0 = cz/H_X$ or light spaces r as inferred from the ECM Hubble law, should also give distorted values of SNe $\langle M \rangle$, $M(z_0)$, $M^*(z_0)$ to a wide Galaxy entourage, including the Huge Void (Bahcall & Soneira 1982) and the expansion center at $R_0 \approx 260 \text{ Mpc}$ from the Local Group (cf. papers I-II and author 1991). Indeed, only the very nearby Universe, at $z_0 \lesssim 0.007$ or $D \lesssim 30 \text{ Mpc}$, should be somewhat independent from the cosmic rotation, owing to the Galilean relativity effect within the ECM rigid rotation; on the other hand also the normal or central points of the deep Universe, at $\langle z \rangle \equiv z_0 \gtrsim 0.4$ or $D \gtrsim 1000 \text{ Mpc}$, result to be negligibly affected by the cosmic rotation, probably thanks to a better statistical merging of the individual z points. Here we must remark that, according to the rotating Universe calculated in paper VII, the transversal velocity of the Galaxy, $R_0 \dot{\vartheta}_0 \approx 6 \times 10^9 \text{ cm/s}$, is more than three times the radial velocity, $\dot{R}_0 \approx 1.8 \times 10^9 \text{ cm/s}$. Therefore the observed redshift z from the Milky Way must also be linked to a relative motion of differential rotation, which however is inconsistent with the ECM rigid rotation. In conclusion the magnitude anomaly of the SNe Ia at low $\langle z \rangle$ may be technically interpreted as due to a deficiency in the used magnitude formulas, which produce a maximum peak of deviation, with a resulting systematic $\Delta M \approx 1$ at $0.04 \lesssim \langle z \rangle \lesssim 0.08$, that is in the Hubble depth range $170 \text{ Mpc} \lesssim D \lesssim 350 \text{ Mpc}$.

6.6 Fitting 15 values of High- z SNe $\langle M \rangle$, $M(z_0)$, $M^*(z_0)$ versus z_0 and r

As a consequence of the previous results, a correct analysis of the SNe Ia absolute magnitudes (cf. eqs. 39-42-47-50) must necessarily be limited to the data of Table 7, that of a deep Universe whose magnitude anomaly seems to be negligible within the limits of the present astronomical measurements.

Fitting the 15 points $\langle M \rangle$ (cf. Table 7) plotted versus z_0 and $r(z_0)$ leads to the line equations, $\langle M \rangle(z_0)$ and $\langle M \rangle(r)$, representing the normal Hubble Magnitude of the supernovae Ia, as a function of the central redshift z_0 and light space $r(z_0)$. The solutions from the following automatic cubic and linear fittings (cf. Appendix Figures 22-23)

$$\langle M \rangle(z_0) = A_0 + A_1 z_0 + A_2 z_0^2 + A_3 z_0^3 \quad (53)$$

$$\langle M \rangle(r) = C_0 + C_1 r(z_0) \quad (54)$$

, whose corresponding coefficients of determination $\mathbf{R}^2 = 0.9948$ and $\mathbf{R}^2 = 0.9950$ respectively, give the values:

$$A_0 = -18.26 \quad A_1 = -3.351 \quad A_2 = +2.636 \quad A_3 = -0.8485 \quad (55)$$

$$C_0 = -17.86 \quad C_1 = -0.002138 \quad (56)$$

Fitting the 15 points $M(z_0)$, (cf. Table 7) plotted versus z_0 and $r(z_0)$ leads to the line equations, $M(z_0)$ and $M(r)$, representing the central Hubble Magnitude of the supernovae Ia, as a function of the central redshift z_0 and light space $r(z_0)$. The solutions from the following automatic cubic and linear fittings (cf. Appendix Figures 24-25)

$$M(z_0) = A_0 + A_1 z_0 + A_2 z_0^2 + A_3 z_0^3 \quad (57)$$

$$M(r) = C_0 + C_1 r(z_0) \quad (58)$$

, whose corresponding coefficients of determination $\mathbf{R}^2 = 0.9939$ and $\mathbf{R}^2 = 0.9923$ respectively, give the values:

$$A_0 = -18.38 \quad A_1 = -3.188 \quad A_2 = +2.681 \quad A_3 = -0.9603 \quad (59)$$

$$C_0 = -17.95 \quad C_1 = -0.002061 \quad (60)$$

Fitting the 15 points $M^*(z_0)$ (cf. Table 7) plotted versus z_0 and $r(z_0)$ leads to the line equations, one of $M^*(z_0)$ and two of $M^*(r)$, representing the new central absolute magnitude of the supernovae Ia, as a function of the central redshift z_0 and light space $r(z_0)$. The solutions from one quadratic and two linear automatic fittings (cf. Appendix Figures 26-27-28)

$$M^*(z_0) = A_0 + A_1 z_0 + A_2 z_0^2 \quad (61)$$

$$M^*(z_0) = A_0 + A_1 z_0 \quad (62)$$

$$M^*(r) = C_0 + C_1 r(z_0) \quad (63)$$

, whose corresponding coefficients of determination $\mathbf{R}^2 = 0.8883$, $\mathbf{R}^2 = 0.8772$ and $\mathbf{R}^2 = 0.8353$, respectively, give the values:

$$A_0 = -17.87 \quad A_1 = -0.02420 \quad A_2 = -0.1199 \quad (64)$$

$$A_0 = -17.81 \quad A_1 = -0.2071 \quad (65)$$

$$C_0 = -17.57 \quad C_1 = -4.831E - 04 \quad (66)$$

6.7 A final solution for the SNe Ia $\langle M \rangle$ and $\langle M^* \rangle$

Each solution in the previous sections has given an extrapolated value of the absolute magnitude $\langle M_\alpha \rangle(z_0 \rightarrow 0)$ as $M_0 = A_0$ or $M_0 = C_0$. Thus the solution here adopted for the absolute magnitude M_0 of the supernovae Ia, from the mathematical mean of the 9 values listed above, is the following:

$$M_0 = -17.9 \pm 0.1 \quad (67)$$

Once the starting point has been fixed at this $M_0 = -17.9$, a solution of the SNe Ia $\langle M \rangle$ and $\langle M^* \rangle$ can be found taking into account **only the best normal points, that is the core of the available data**, those based on z bins with individual $z \geq 0.4$ and a number $N \geq 60$ as a minimum limit for the SNe included in the normal point. In particular the choice for $\langle M \rangle$ includes 9 normal points from paper IX Table 2 and the 4 ECM normal points here listed as $\langle M_z \rangle$ in Table 8, while that for $\langle M^* \rangle$ includes only the 4 ECM normal points of Table 8.

Fitting the plot of the 9 core points $\langle M \rangle$ from paper IX Table 2 and the starting point $M_0 = -17.9$, both versus $\langle z \rangle \equiv z_0$ and $r(z_0)$, leads to the line equations, $\langle M \rangle(z_0)$ and $\langle M \rangle(r)$, representing **the normal Hubble Magnitude of the supernovae Ia**, as a function of the central redshift z_0 and light space $r(z_0)$. The solutions of the following automatic cubic and linear fittings (cf. Appendix Figures 29-31)

$$\langle M \rangle(z_0) = A_0 + A_1 z_0 + A_2 z_0^2 + A_3 z_0^3 \quad (68)$$

$$\langle M \rangle(r) = C_0 + C_1 r(z_0) \quad (69)$$

, whose corresponding coefficients of determination $\mathbf{R}^2 = 0.99992$ and $\mathbf{R}^2 = 0.9996$ respectively, give the values:

$$A_0 = -17.900 \quad A_1 = -4.2618 \quad A_2 = +3.2507 \quad A_3 = -0.90878 \quad (70)$$

$$C_0 = -17.90 \quad C_1 = -0.002091 \quad (71)$$

The parallel check solutions based only on the 9 points $\langle M \rangle$ without $M_0 = -17.9$ (cf. Appendix Figures 30-32) give $\mathbf{R}^2 = 0.9974$ and $\mathbf{R}^2 = 0.9943$, with $A_0 = -18.11$ and $C_0 = -17.75$, respectively.

An alternative solution is based on the 4 ECM normal points of Table 8, which was constructed by combining the core points from Table 0 of section 3.1 with those from Table 4 of section 5.

Table 8

N	z bin	$\langle z \rangle$	$\langle m \rangle$	$\langle r_z \rangle$	$\langle M_z \rangle$	$\langle M^* \rangle$
200	$0.4 \leq z < 1.4$	0.677	23.763	793.0	-19.567	-17.928
149	$0.5 \leq z < 1.4$	0.756	24.052	830.4	-19.650	-17.951
107	$0.6 \leq z < 1.4$	0.837	24.339	865.6	-19.719	-17.961
75	$0.7 \leq z < 1.4$	0.919	24.627	898.9	-19.773	-17.954

Fitting the plot of the 4 ECM points $\langle M_z \rangle$ of Table 8 and the starting point $M_0 = -17.9$, both versus $\langle z \rangle \equiv z_0$ and $\langle r_z \rangle$, leads to the line equations, $\langle M_z \rangle(z_0)$ and $\langle M_z \rangle(\langle r_z \rangle)$, representing **the ECM normal Hubble Magnitude of the supernovae Ia**, as a function of the central redshift z_0 and light space $\langle r_z \rangle$. The solutions of the following automatic cubic and linear fittings (cf. Appendix Figures 33-35)

$$\langle M_z \rangle(z_0) = A_0 + A_1 z_0 + A_2 z_0^2 + A_3 z_0^3 \quad (72)$$

$$\langle M_z \rangle(\langle r_z \rangle) = C_0 + C_1 \langle r_z \rangle \quad (73)$$

, whose corresponding coefficients of determination $\mathbf{R}^2 = 1.0000$ and $\mathbf{R}^2 = 0.99990$ respectively, give the values:

$$A_0 = -17.900 \quad A_1 = -4.0675 \quad A_2 = +2.8270 \quad A_3 = -0.67334 \quad (74)$$

$$C_0 = -17.901 \quad C_1 = -0.0020968 \quad (75)$$

The parallel check solutions based only on the 4 points $\langle M_z \rangle$ without $M_0 = -17.9$ (cf. Appendix Figures 34-36) give $\mathbf{R}^2 = 0.9999$ and $\mathbf{R}^2 = 0.9954$, with $A_0 = -18.12$ and $C_0 = -18.03$, respectively.

Indeed, the high reliability of the 4 ECM normal points of Table 8 is clearly shown by the very precise solutions above listed, which are very near to those derived from the previous 9 points $\langle M \rangle$ from paper IX Table 2. Consequently these 4 **ECM normal points** are here considered **pilot points** also for finding a better trend of the new absolute magnitude M^* of the supernovae Ia.

Fitting only the plot of the 4 core points $\langle M^* \rangle$ listed in Table 8 (excluding the starting point $M_0 = -17.9$), both versus $\langle z \rangle \equiv z_0$ and $\langle r_z \rangle$, leads to the line equations, $\langle M^* \rangle(z_0)$ and $\langle M^* \rangle(\langle r_z \rangle)$, representing **the new normal absolute magnitude of the supernovae Ia**, as a function of the central redshift z_0 and light space $\langle r_z \rangle$, with $\langle M^* \rangle(z_0) \equiv \langle M^* \rangle(\langle r_z \rangle) \equiv \langle M_\alpha \rangle(z_0)$ assumed.

The solutions from both the automatic linear fittings (cf. Appendix Figures 37-38), that is

$$\langle M^* \rangle(z_0) = A_0 + A_1 z_0 \quad (76)$$

and

$$\langle M^* \rangle(\langle r_z \rangle) = C_0 + C_1 \langle r_z \rangle \quad (77)$$

, whose corresponding coefficients of determination $\mathbf{R}^2 = 0.6237$ and $\mathbf{R}^2 = 0.6564$ respectively, give the values:

$$A_0 = -17.86 \quad A_1 = -0.1084 \quad (78)$$

$$C_0 = -17.73 \quad C_1 = -0.0002541 \quad (79)$$

The 6 previous fittings carried out without the starting point $M_0 = -17.9$ give again an extrapolated absolute magnitude $\langle M_\alpha \rangle(z_0 \rightarrow 0)$ as $M_0 = A_0$ or $M_0 = C_0$. Hence the computed solution for the absolute magnitude M_0 of the supernovae Ia, from the mathematical mean of the 6 values listed above, is here confirmed to be the following:

$$M_0 = -17.93 \pm 0.08 \quad (80)$$

Finally, the solutions here proposed for the SNe $\langle M \rangle$ and $\langle M^* \rangle$ permit the computation of both the total M spread and the absolute magnitude M_α when $M_\alpha \equiv M^*$ is assumed, according to paper XV and paper X Appendix. Table 9 lists 5 spread values (in second, fourth and sixth column) following the 3 solutions (70)(74)(78), calculated at the 5 different $\langle z \rangle \equiv z_0$ of the first column. In addition Table 9 also reports the relativistic value of the deceleration parameter which results by applying the total spread of the extrapolated Hubble Magnitudes $\langle M \rangle(z_0)$ and $\langle M_z \rangle(z_0)$ at $z_0 = 0.001$ into the q_0 formula (59) of the parallel paper XV (or A19 of paper X).

Table 9

z_0	$\langle M \rangle(z_0) - M_0$	q_0	$\langle M_z \rangle(z_0) - M_0$	q_0	$\langle M^* \rangle(z_0) - A_0$
0.001	-0.004259	+2.92	-0.004065	+2.74	-0.000109
0.01	-0.04229		-0.04039		-0.00108
0.1	-0.3946		-0.3792		-0.0108
0.5	-1.432		-1.411		-0.0542
1	-1.920		-1.914		-0.1084

6.8 The new absolute magnitude M^*

At the end of this magnitude analysis, the coincidence between the intrinsic absolute magnitude M_α with the new absolute magnitude M^* (cf. paper XV, paper XI Addendum Note, paper X Appendix) must also be shown theoretically, summed up in the identity

$$M_\alpha \equiv M^* = m - 5 \log D_L - 25 \quad (81)$$

with

$$D_L = r \cdot (1 + z)^2 = r_0 \cdot (1 + z) \quad (82)$$

as a new formulation of the luminosity distance D_L , which differs from relativistic cosmology in that, here, the light space $r = -c\Delta t$ is a physical distance, representing the space run by light during the past travel time $\Delta t = t - t_0$, in place of the relativistic proper distance r_{pr} at the emission epoch t (cf. section 2 of paper VIII, IX, XV).

Mathematically, such light-space r in eq. (82) is the same r we find in Milne's cosmology (Rowan-Robinson 1996) as the distance at the emission epoch; however the "cosmic medium" (CM), with respect to which light moves at constant speed $c = \lambda/T$, is expanding as does the whole Universe. Consequently, also λ and T increase, because of the CM expansion with the constancy of c . As a result, the light-space r is larger than the distance at the emission epoch, although its value in light-time represents a measure of that past epoch t .

The same, $r_0 = r \cdot (1 + z)$ in eq. (82) seems to substitute the relativistic proper distance at the present epoch t_0 , while its meaning has yet to be found within expansion center cosmology.

In conclusion the physical demonstration of eq. (82) is possible, but such a task must belong rigorously to the theoreticians.

7. Conclusions

The present paper, after the parallel paper XV, is the latest in a series of ECM papers, containing important new results, based on the fundamental SCP Union data, in addition to the further reconfirmation of the expansion center model.

A few remarks and concluding statements on the topic may be summarized as follows:

0) The preliminary empirical model of the expansion center Universe (Lorenzi 1989) led to a confirmed dipole equation of the Hubble ratio (Lorenzi 1991-93); after the discovery of a high rate of variation of the Hubble constant in the nearby Universe (Lorenzi 1994), a more rigorous formulation of the new Hubble law was developed and studied in terms of possible outcomes. The expansion center model (ECM) is the proposed solution in the 1999 papers I and II;

1) The adjective "model independent", first of all means the exclusion of the ECM formalism of paper II, as specified in the "Introduction" of paper XV. In this sense papers V, VI, IX, XV may be considered model independent papers;

2) The formulation for the wedge-shape of the new Hubble law, or new Hubble D law, implies a clear Hubble ratio dipole, as $cz/D = H_0 - a^*(D) \cos \gamma$, where the Hubble depth $D = D_C/(1+z)$ can be calculated through the M value which produces the identity $D_C \equiv D_L = 10^{0.2(m-M)-5}$;

3) The relation (22) in paper IX, expressing the average trend of the SNe Hubble Magnitude $M(z_0) = d_0 + d_1 D + d_2 D^2 \equiv \langle M \rangle$, was constructed by using the normal ECM M equation (21) from paper IX, with $H_0 = 70$ H.u. assumed and without including the ECM dipole terms of 398 *SCPU* supernovae. In practice that means the adoption of an ECM-independent procedure;

4) Without doubt, paper XV has produced two significant results, that is a model independent confirmation both of the Hubble ratio dipole and of the angular coefficient $a^* = 5.5$ H.u. predicted by the ECM at the central redshift $z_0 \equiv \langle z \rangle = 1.0$ or Hubble depth $D \cong 4283$ *Mpc*;

5) Unlike in paper XV, the dipole analysis of this paper XVI was based on the adoption of the ECM, to make possible the check test of the ECM standard value, $a_0 = 12.7$ H.u.. A similar procedure was applied also in paper VI and in its integral version;

6) A new finding from paper XVI is a clear macroscopic discovery of large ΔM in SNe Ia, which consequently, at the present time, are not usable standard candles when taken individually;

7) A secondary result from paper XVI is the resulting drop in the scattering ΔM with the Hubble depth D , more likely according to the relationship $\langle |\Delta M| \rangle \cong 1.4 - 0.15 \ln(D)$;

8) In addition to the previous relationship, the available data set of Table 3 seems to suggest

the preliminar correlation $\langle |\Delta M| \rangle \approx 0.34 - 0.10 \cdot \cos \gamma$, only at redshifts $z \lesssim 0.5$ (cf. Appendix Figure 7);

9) Another important outcome of the present "Dipole analysis..." is the evidence for a clear perturbation effect on ECM of the SNe ΔM at $z \lesssim 0.5$;

10) The above cited perturbation effect of ΔM , after introducing the weights $w_i \propto |\Delta M|^{-i}$, allows both a further reconfirmation of the expansion center model at any Hubble depth D and, at the same time, the demonstration of the adopted $\langle M \rangle = d_0 + d_1 D_z + d_2 D_z^2$ being able to accurately reproduce the predicted Hubble ratio dipole when $\Delta M \rightarrow 0$;

11) The unweighted dipole tests, that is with $w_0 = 1$, directly confirm the ECM at $z \gtrsim 0.5$, since the mathematical mean of all the 10 a_0 values, those resulting from W18-W19-W20-W21-W22 of Table 1 and A18-A19-A20-A21-A22 of Table 2, becomes $\langle a_0 \rangle = 12.0 \pm 0.6$ H.u., while the above best 5 fittings in Table 1 give $\langle a_0 \rangle = 12.8 \pm 0.7$ H.u.. Once again these average values agree very well with the ECM, being 12.7 H.u the standard value of a_0 ;

12) A further result here reported is some astronomical evidence for intrinsic SNe Ia ΔM ;

13) The magnitude anomaly of the *SCPU* supernovae at low redshifts, with an observed maximum peak of $\Delta M \approx 1$ in the range $0.04 \lesssim \langle z \rangle \lesssim 0.08$ (cf. Appendix Figures 16-18-20), is the most important finding in paper XIII, which has been rolled out in paper XVI ;

14) The negative collapse of the SNe M at $\langle z \rangle \approx 0.06$ in a range $0.007 \lesssim \langle z \rangle \lesssim 0.4$ is here considered to be structural and due to the cosmic rotation, which should affect significantly the usual magnitude formulas for a wide Galaxy entourage, including the Huge Void (Bahcall & Soneira 1982) and the expansion center at $R_0 \approx 260$ Mpc (cf. ECM papers I-II and author 1991);

15) Once the perturbation zone on the SNe M is removed, the luminosity analysis of high z SNe Ia has allowed the extrapolation of the corresponding absolute magnitude M_0 value at a central redshift $z_0 \rightarrow 0$. The final result is $M_0 = -17.93 \pm 0.08$;

16) The extrapolated trend of the normal Hubble Magnitude $\langle M \rangle$ of the supernovae Ia at low central redshifts $z_0 \equiv \langle z \rangle \ll 1$, according to $\langle M \rangle = \langle m \rangle - 5 \langle \log [D(1+z)] \rangle - 25$ with $D = cz/H_X \equiv cz_0/H_0$, presents a sharp negative increase with z_0 , which clearly contrasts with the almost constant trend due to a relativistic $q_0 \approx -1$ (cf. paper XV and paper X Appendix);

17) The new ECM absolute magnitude of the supernovae Ia, that M^* based on a luminosity distance $D_L = r_z \cdot (1+z)^2$ where $r_z = -c(t - t_0)$ is the light space resulting from the **ECM** z **equation** as space run by light at constant speed c into the expanding "cosmic medium" or Hubble flow, shows here a slowly increasing negative trend, that is: $\langle M^* \rangle = -17.9 - 0.1 \times z_0$, with

$z_0 \equiv \langle z \rangle$ assumed;

18) Two precise values of the determination coefficient, that is $\mathbf{R}^2 = 0.99992$ and $\mathbf{R}^2 = 1.0000$, from the final cubic fittings of $\langle M \rangle(z_0)$ and $\langle M_z \rangle(z_0)$ respectively, give the corresponding total M spread in Table 9 a high accuracy. As a consequence, the more reliable value of the relativistic deceleration parameter q_0 here is about $+3$;

19) The intrinsic absolute magnitude M_α is found to coincide with the new absolute magnitude M^* , that is $M_\alpha \equiv M^*$, based both on empirical and theoretical results;

20) After the strong experimental evidence for the expansion center and some mechanical investigations about the Universe as a whole, according to the ECM papers series, this paper XVI presents a noteworthy observational proof of the cosmic rotation, that is the magnitude anomaly of the nearby supernovae Ia. Thus Gamow (1946) was right to propose a "Rotating Universe?" to Einstein, however unsuccessfully (cf. Kragh 1996). Actually there are other important astronomical proofs on the topic (cf. Longo 2011). The conclusion might be in favour of a Big Bang as a Big Crush, when the ECM cosmic mechanics with angular momentum conserved (cf. paper VII and VIII) is applied even to Lemaître primitive atom (1946).

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10. APPENDIX: Atlas of the ECM paper XVI figures

All the plots and graphical fittings of this "Dipole and absolute magnitude analysis of the SCP Union supernovae ..." appear in the following check atlas of 38 figures and their corresponding legends.

The atlas uses Hubble units; therefore the abscissae as Hubble depth D_z or the mean $\langle D_z \rangle$, light space $r(z_0)$ or $\langle r_z \rangle$ are in Megaparsecs, while $\langle z \rangle \equiv z_0$ is normal redshift; the abscissae as $\cos \gamma$, $-X$ or the mean $\langle -X \rangle$ are dimensionless; the ordinates as $|\Delta M|$, $\langle |\Delta M| \rangle$, M_z , $\langle M_z \rangle$, $\langle M \rangle$, $M(z_0)$, $M^*(z_0)$, $\langle M^* \rangle$ are magnitudes; the ordinates as Y are in $km\ s^{-1} Mpc^{-1}$.

In the cartesian plane (x, y)

of Figures 3-4-5-6-8-9-10-11-12-13-14-15-22-23-24-25-26-27-28-29-30-31-32-33-34-35-36-37-38

the resulting fitting equations, as $y = f(x)$, are included, together with the coefficient of determination \mathbf{R}^2 .

The diagrams of Figures 16-17-18-19-20-21 highlight the magnitude anomaly of the low $\langle z \rangle$ points. In particular **Figure 20**, that presents the plot of 30 SNe new central absolute magnitudes $M^*(z_0)$ versus $\langle z \rangle = z_0$ from SCP Union data of 398 supernovae Ia, gives clear empirical evidence for the normal luminosity behaviour of the supernovae Ia of the deep Universe in comparison with the SNe Ia magnitude trend of the nearby Universe, where we can see a maximum peak of M^* deviation, with a resulting systematic $\Delta M^* \approx 1$ at $0.04 \lesssim \langle z \rangle \lesssim 0.08$, that is in the Hubble depth range $170\ Mpc \lesssim D \lesssim 350\ Mpc$. Note that the distance of the expansion center from the Local Group at the present epoch t_0 results to be $R_0 \approx 260\ Mpc$, according to the ECM.

Lastly, the high reliability of the core points in Table 8 is clearly shown by the plots and precise fittings of Figures 33-34-35-36. Thus these 4 **ECM normal points** become **pilot points** also in Figures 37-38, to represent two linear trends of the new normal absolute magnitude $\langle M^* \rangle$ of the supernovae Ia.

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